INSTALLATION, START-UP AND OPERATION MANUAL

AIR COOLED SCREW LIQUID CHILLERS ASQ045B – ASQ440B

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GENERAL

INTRODUCTION

ZAMIL Cooline ASQ-Series liquid chillers are manufactured to provide engineering excellence in comfort air conditioning and industrial cooling with a superior combination of energy saving, performance, application flexibility, ease of service & maintenance, environmental friendliness and ability to withstand extreme ambient temperatures.

This manual contains all the information required for correct installation, start-up and commissioning of the units, together with operating instructions. The manual should be read thoroughly before attempting to perform any of the aforesaid tasks and all procedures and instructions detailed in this manual must only be carried out by suitably trained and qualified personnel. The manufacturer will not be liable for any personnel injury or equipment damage caused by incorrect installation, commissioning or operation resulting from a failure to follow and implement the procedures, instructions and recommendations detailed in this manual.

SCOPE OF THIS MANUAL

The contents of this manual include suggested best working practices and procedures. These are issued for guidance only and they do not supersede governing local safety codes/regulations nor the individual responsibility of the personnel working on these units who shall remain primarily responsible for their own safety and the equipment as well.

This manual, and any other documents supplied with the unit, are the sole property of Zamil Air Conditioners, which reserves all rights. They may not be reproduced or distributed in any form or by any means, without prior written permission from Zamil or its representatives.

In accordance with our policy for continuous research and product improvement, the information contained in this manual is subject to change without notice. While Zamil makes no commitment to update or provide current information automatically to the manual owner, that information, if applicable, can be obtained by contacting the nearest Zamil or its representative's offices. It is the responsibility of operating/service personnel to verify applicability of this manual to the equipment involved. If they have any doubt with regards to the applicability of this document, then, prior to working on the equipment, they should verify with the owner whether the equipment has been modified/ improved and if current literature is available.

SAFETY CONSIDERATIONS & SYMBOLS

This equipment is a complex engineering product and the personnel involved during installation, operation, maintenance or service, may be exposed to certain components or conditions including, but not limited to: refrigerants, oils, pressurized components, rotating parts and both high and low voltages. Each of these items has the potential, if misused or handled improperly, to cause injury or death. It is the obligation of operating/service personnel to identify and recognize these inherent hazards, protect themselves and proceed safely in completing their tasks. Failure of the personnel to comply with any of these requirements could result in serious damage to this equipment and the facility, in which it is installed, as well as severe injuries or death to themselves and other people at the site.

This manual is intended for use by owner authorized operating/service personnel. It is expected that these personnel are suitably trained and qualified which will enable them to perform their assigned tasks properly and safely. It is essential that prior to performing any task on this equipment, the personnel must have thoroughly read and understood this manual, all tags and stickers on the units and any other applicable documents. These people shall also be cognizant of and comply with all applicable local codes and regulations pertaining to the job on hand.

The major safety considerations are as follows and must be exercised during application, installation, start-up and operation of these units:

Proper Design & Operation: These chillers are designed for cooling water or glycol solutions and not suitable for purposes other than those specified in our application catalogue. Any misuse of this equipment, may result in injury to the operator or damage to equipment. The units must not be operated beyond the domain of performance data furnished in our application catalogue.

Foundation, Support & Isolation: Suitable structural support and vibration isolation must be provided as indicated in these instructions. Failure to do so may result in injury to the operator or damage to the equipment and/or building.

Discard Intrusions: The units are not designed to bear additional loads or stresses from adjacent equipment, pipework or structures. Additional components must not be mounted on these units. Any such external loads may overload the units and cause structural failure resulting in injury to the operator or damage to equipment.

Restricted Access to Equipment: This equipment is a complex engineering product and there are a number of areas and features which may be a hazard and potentially cause injury when working on the unit unless suitable safety precautions are taken. It is necessary to ensure that access to the unit is restricted to suitably qualified personnel who are familiar with the potential hazards and precautions required for safe operation and maintenance of this equipment.

High Pressure & Temperature System: The units contain refrigerant vapor and liquid under high pressure and temperature and release of which can be dangerous and cause injury. The user should ensure that care is taken during installation, operation and maintenance to avoid damage to the pressure system. Access to component parts of the pressure system shall be restricted to suitably trained and qualified personnel only.

Electrical: The units must be grounded. No installation or maintenance work should be attempted on the units without first switching OFF, isolating and locking off the power supply. Work on live equipment must only be carried out by suitably trained and qualified personnel. No attempt should be made to gain access to the control panel or electrical enclosures during normal operation of the units.

Rotating Parts: Fan guards must remain fixed in their position at all times and if any need arises to remove them for inspection or maintenance, then remove the guards only after the power supply has been isolated.

Sharp Edges: The fins on the air-cooled condenser coils have sharp metal edges. Sufficient care should be taken when working in contact with the coils to avoid the risk of abrasions and lacerations. The use of gloves is recommended.

Refrigerant and Compressor Oil: Refrigerants and oils used in the units are non-flammable and non-corrosive and do not pose a serious hazard. However, use of safety shoes, gloves and safety goggles is strongly recommended when working on these units. Avoid direct skin or eye contact with the refrigerant as it results in frostbite injury. Further, attention should be given to good ventilation when working in confined or enclosed spaces, as the build-up of refrigerant vapor, from a leak for example, does pose a risk of asphyxiation.
For more detailed information on safety precautions for use of refrigerant, please refer Material Safety Data Sheet given in the Appendix of this manual.

High Temperature and Pressure Cleaning: High temperature and pressure cleaning methods like hot water or steam cleaning should not be used on any part of the pressure system as this will cause excessive pressure in the system and trigger operation of the pressure relief device(s). Detergents and solvents which may cause corrosion should also be avoided.

The following symbols are used in this manual to alert the reader:

WARNING denotes a potentially hazardous situation which, if not avoided, could result in serious injury or death.

CAUTION denotes a hazard which could lead to damage to the unit and damage to other equipment.

ATTENTION is used to remind or highlight useful information.

WARRANTY

ZAMIL warrants all operating parts in this equipment against factory defects for a period formally agreed upon in the relevant sales contract. All warranty claims must be supported by proper documentary evidence like copies of invoices, start-up check out reports, maintenance records etc. to justify the validity of warranty.

In order to avail the warranty, the following requirements must be satisfied:

- The initial Start-up and Commissioning of the units must be carried out by suitably trained and qualified personnel only preferably *by Zamil* in accordance with the instructions given in this manual.
- Upon completion of Start-up and Commissioning, duly filled up and certified check out forms for each unit (sample check out form given in this manual) should be submitted to Zamil Head Office, Dammam.

This warranty is conditional and nullifies if any of the following violations are committed:

- Units are not properly stored, protected or inspected by the client during the period from date of shipment till date of initial start-up.
- Incorrect installation, start-up & commissioning and operation resulting from a failure to follow and implement the procedures, instructions and recommendations given in this manual.
- Equipment is operated without or improperly installed field devices such as water flow switch and chilled water pump interlocking with chillers.
- Any modification to the units which includes changing, adding or removing certain components, altering the electrical wiring or whatsoever without prior written approval from ZAMIL.
- Insufficient maintenance or non-compliance to the maintenance requirements specified in this manual. Also, maintenance, service or repair carried out by unqualified personnel.
- Any misuse of this equipment such as, utilizing it for purposes other than those its designed for and operating outside the design parameters specified in our application catalogue.
- Equipment is operated with refrigerant, oil, water or antifreeze agents which are not approved by ZAMIL.
- Equipment has been damaged due to malfunctioning of interface controllers such as DDC, periphery components etc.
- Equipment has been damaged by freezing due to improper protection during cold weather or damaged by accident, fire or any other conditions not ordinarily encountered (force majeure).

PRODUCT INFORMATION

MODEL DESIGNATION DETAILS

1,2 & 3 BASIC (SERIES)	4,5 & 6 UNIT SIZE		7 REFRIGERANT	8 ELECTRICAL SUPPLY (V-Ph-Hz)	9 CONDENSER TYPE	10 CIRCUIT BREAKER OPTIONS	11 COOLER OPTIONS	12 HGBP OPTIONS	13 & 14 OPTIONS & ACCESSORIES
ASQ COOLINE AIR COOLED SCREW WATER CHILLERS	45 50 55 60 70 80 90 100 115 130 140 150 160 170 180 190 200	220 230 240 250 260 270 280 300 320 330 340 350 360 380 400 420 440	B:R-134a	L:380/415-3-50 (4WIRE)	A:ALUMINUM FINS B:PRECOATED ALUM FINS C: COPPER FINS (SEE NOTE 1 BELOW)	A:STANDARD B:COMPRESSOR CIRCUIT BREAKER	A:STD. WITH VICTAULIC CONNECTION B:FLANGE CONNECTION (OPTIONAL) C: ASME STAMPED WITH VICTAULIC CONNECTION (OPTIONAL) D: ASME STAMPED WITH FLANGE CONNECTION (OPTIONAL)	A: STD. UNIT WITHOUT HGBP B: HGBP (OPTIONAL)	SEE NOTE # 2 BELOW

NOTE 1: FOR OTHER COATING SPECIFY YOUR REQUIREMENTS IN WRITING.
NOTE 2: COMPUTER SELECTED DIGITS (FROM AA to ZZ) DESCRIBING ALL OTHER FEASIBLE OPTIONS & ACCESSORIES OR COMBINATIONS THEREOF SUCH AS CONDENSER COIL GUARD, COOLER GUARD, UNIT DISCONNECT SWITCH, COMPRESSOR ENCLOSURE, WATER FLOW SWITCH, SPRING ISOLATORS ETC.

MAJOR FEATURES

These chillers incorporate a wide range of features; some of them are as follows:

- Compact unit design and excellent serviceability.
- Single skid designed.
- Single point power connection.
- Steel sheet panels are zinc coated and galvanized conforming to **ASTM A-653** commercial weight G-90 followed by electrostatic polyester dry powder coat.
- High energy efficiency ratio (EER) semi-hermetic compact twin screw compressors.
- Compact design shell & tube liquid cooler with enhanced inner grooved copper tubes bundled into U-shape and expanded into a steel tubular sheet.
- Control panel design is equivalent to **NEMA 4.**
- Internal power & control wiring cable identification & markers as per **NEC.**
- Electrical controls used in the control panel are **UL approved or equivalent.**
- Complete wired control panel with advanced microprocessor based controller.
- Compressors are provided with **Part Winding Start**.
- Low noise condenser fans, direct drive with rolled venturi design to eliminate short circuiting of airflow.
- All fans are die cast aluminum propeller type with aerodynamic design, top discharge & provided with protective grille.
- All fan motors are Totally Enclosed Air Over (TEAO) type with class "F" winding insulation, ball bearings & inherent thermal protection of automatic reset type.

STANDARD CONTROL & SAFETY DEVICES AND OTHER ACCESSORIES

The chillers are provided with the following items as a standard practice:

Microprocessor Controller: This controller monitors analog and digital inputs to achieve precise control & safety functions of the unit.

Compressor In-Built Protection Device: Protect the compressor by monitoring:

a. Motor winding temperature in case of overload.
b. Discharge gas temperature in case of overheating.
c. Phase reversal for direction of rotation.

Starters: The starter is operated by the control circuit and provides power to the compressor motors. These devices are rated to handle safely both RLA and LRA of motors.

Under/Over Voltage and Phase Protection: Protects against low/over incoming voltages as well as single phasing, phase reversal and phase imbalance by de-energizing the control circuit. It is an automatic reset device, but it can be setup for manual reset.

Crankcase Heaters: Each compressor has crankcase heater. The compressor crankcase heater is always on when the compressors are de-energized. This protects the system against refrigerant migration, oil dilution and potential compressor failure.

High Pressure Switch: This switch provides an additional safety protection in the case of microprocessor failure to cut-out on high pressure alarm.

Unit On-Off Switch: On-Off switch is provided for manually switching the unit control circuit.

Indicator Lights: LED lights indicate power ON to the units, MENU adjustment and FAULT indications due to trip on safety devices.

Electronic Expansion Valves: Electronic expansion valve is used to regulate the refrigerant flow to the water cooler and maintain a constant superheat and load optimization.

Replaceable Core Type Filter Drier: Refrigerant circuits are kept free of harmful moisture, sludge, acids and oil contaminating particles by the filter drier.

Control Circuit Transformer: For units rated with 460V-3Ph-60Hz power supply factory mounted and wired control circuit transformer is furnished eliminating the need for running a separate 220-volt power supply to the unit control circuit.

Sight Glass: Moisture indicating sight glass installed in the liquid line. An easy-to-read color indicator shows moisture contents and provides a mean for checking the system refrigerant charge.

Liquid Line Solenoid Valves: Closes when the compressor is off to prevent any liquid refrigerant from accumulating in the water cooler during the off cycle.

OPTIONAL FEATURES

The chillers can be provided with the following items based on specific client/project requirements:

Hot Gas Bypass System: Hot gas bypass is provided on the lead circuit to permit operation of the system down to 50% of its unloaded capacity. Under low ambient condition, it controls temperature by eliminating the need to cycle the compressor on and off, ensuring narrow temperature swing and lengthen the life span of the compressor.

Water Flow Switch: Paddle type field adjustable flow switch for water cooler circuits. Interlock into unit safety circuits so that the unit will remain off until water flow is determined.

Unit Mount Spring Isolators: This housed spring assemblies with a neoprene friction pad on the bottom dampen the vibration transmission.

Compressor Circuit Breakers: Protects against compressor branch circuit fault. When tripped (manually or automatically), the breaker opens the power supply to the compressor and control circuit through auxiliary contacts.

Liquid Coolers: ASME code stamped liquid cooler.

Pressure Gauges: Suction & discharge pressure gauges.

Non-Fused Main Disconnect Switches: De-energize power supply during servicing/repair works as well as with door interlock.

Condenser Coil Guard: Protect the condenser coil from physical damage.

Compressor/Cooler Guard: Protect the compressor from vandalism.

Compressor Enclosure Box: Reduce compressor operating noise and keep the compressor clean.

Cooler Heater Wrapped: Prevent freezing up of water on low ambient temperature.

Copper Fins & Tubes Condenser Coils: For seashore salty corrosive environments.

Anti-corrosive Coated Condenser Coils (copper or aluminum fins & copper tubes): For seashore or acid corrosive environments.

BMS Gateway Interface: Interlocking with Building Management Systems.
(BACnet, MODBUS, GSM and Remote Monitoring).

Ground Fault Protection: Provides additional safety protection in the case of abnormal current leakage.

All control & safety devices, accessories and optional items are factory installed except for unit mounting spring isolators and water flow switch, which must be installed on job-site.

PHYSICAL DATA

UNIT SIZE		ASQ045B	ASQ050B	ASQ055B	ASQ060B	ASQ070B	ASQ080B	ASQ090B	ASQ100B	ASQ115B
COMPRESSOR										
PART NUMBER (380/415V-3ph-50Hz)		80068315	80068315	80068318	80068321	80068324	80068315	80068315	80068318	80068321
NUMBER OF COMPRESSORS		1	1	1	1	1	2	2	2	2
OIL CHARGE/COMPRESSOR (liters)		15	15	22	22	22	15	15	22	22
CAPACITY CONTROL RANGE (STEPLESS)		100-50					100-25			
MOTOR OVERLOAD PROTECTION (INTERNAL)		**ELECTRONIC**								
OIL LUBRICATION		**INJECTION**								
TOTAL CRANKCASE HEATER WATTS		200	200	300	300	300	400	400	600	600
REFRIGERANT		**R-134a**								
EXPANSION VALVE		**ELECTRONIC EXPANSION VALVE**								
CONTROL VOLTAGE		**220V-1Ph-50Hz**								
AIRCOOLED CONDENSER										
CONDENSER COIL	Tube Dia.-Rows-FPI	3/8-2-14	3/8-2-14	3/8-3-14	3/8-3-14	3/8-4-14	3/8-3-14	3/8-4-14	3/8-4-14	3/8-4-14
	Total face area, Sq. ft.	87.5	87.5	87.5	87.5	87.5	100.1	100.1	100.1	140
AIRFLOW, CFM		38040	38040	36784	36784	41240	59400	55152	55152	75264
NUMBER OF FANS/FAN DIA; mm		4/762	4/762	4/762	4/762	4/800	6/800	6/800	6/800	8/800
FAN MOTOR RPM @ 380-3-50		915	915	915	915	860	860	860	860	860
COOLER										
PART NUMBER		80066091	80066091	80066091	80066091	80066091	80066092	80065905	80065905	80066052
SHELL DIAMETER,mm		273	273	273	273	273	273	324	324	324
TOTAL LENGTH, mm		1850	1850	1850	1850	1850	1850	2180	2180	2697
WATER HOLDING VOLUME, Liters		53.2	53.2	53.2	53.2	53.2	53.2	99.8	99.8	113.5
WATER IN/OUT PIPE DIA. (mm/in)		100/4	100/4	100/4	100/4	100/4	100/4	150/6	150/6	150/6
ECONOMIZER										
PART NUMBER.		NA	80051633(1)	NA	NA	NA	NA	80051633(2)	NA	NA
EXPANSION DEVICE		NA	T.E.V.	NA	NA	NA	NA	T.E.V.	NA	NA
GENERAL										
NUMBER OF REFRIGERANT CIRCUITS		1	1	1	1	1	2	2	2	2
REFRIGERANT CHARGE, kgs/comp (comp1/2)		27	30	35	38	44	27	30	35	38
SOUND PRESSURE LEVEL,Dba (3m/5m/10m)		72.2/68.7/63.4	72.2/68.7/63.4	72.3/68.8/63.5	75.4/71.9/66.6	75.6/72.1/66.8	74.5/71/65.7	74.5/71/65.7	74.6/71.1/65.8	78.4/74.9/69.6
OPERATING/SHIPPING Wt, kgs		2038/1985	2048/1995	2442/2389	2456/2403	2575/2522	3104/3051	3335/3235	4026/3926	4640/4527

Notes:

1-ALL COMPRESSORS WITH SLIDER CONTROL VALVE UNLOADING

2-ALL COMPRESSORS OPERATE AT 2900 RPM @ 50Hz

3-COOLER VENT AND DRAIN SIZE ARE 1/2" MPT

4-ALL COOLERS ARE SINGLE FACE REFRIGERANT CONNECTION.

5-SOUND PRESSURE LEVEL ± 2 dBA

PHYSICAL DATA

UNIT SIZE		ASQ130B	ASQ140B	ASQ150B	ASQ160B	ASQ170B	ASQ180B	ASQ190B	ASQ200B	ASQ220B
COMPRESSOR										
PART NUMBER (380/415V-3ph-50Hz)		80068324	80068324	80068324	80068318	80068318	80068321	80068321	80068324	80068321(2) 80068318(2)
NUMBER OF COMPRESSORS		2	2	2	3	3	3	3	3	4
OIL CHARGE/COMPRESSOR (liters)		22	22	22	22	22	22	22	22	22
CAPACITY CONTROL RANGE (STEPLESS)		100-25			100-16.3					100-12.5
MOTOR OVERLOAD PROTECTION (INTERNAL)		**ELECTRONIC**								
OIL LUBRICATION		**INJECTION**								
TOTAL CRANKCASE HEATER WATTS		600	600	600	900	900	900	900	900	1200
REFRIGERANT		**R-134a**								
EXPANSION VALVE		**ELECTRONIC EXPANSION VALVE**								
CONTROL VOLTAGE		**220V-1Ph-50Hz**								
AIRCOOLED CONDENSER										
CONDENSER COIL	Tube Dia.-Rows-FPI	3/8-4-14	3/8-3-14	3/8-4-14	3/8-3-14	3/8-4+3-14	3/8-4-14	3/8-4-14	3/8-4-14	3/8-3-14
	Total face area, Sq. ft.	140	175	175	210	210	210	210	210	304
AIRFLOW, CFM		75264	100860	94080	121032	115488	112896	112896	112896	166240
NUMBER OF FANS/FAN DIA; mm		8/800	10/800	10/800	12/800	12/800	12/800	12/800	12/800	16/800
FAN MOTOR RPM @ 380-3-50		860	860	860	860	860	860	860	860	860
COOLER										
PART NUMBER		80066052	80066055	80066055	80066059	80066059	80066059	80066062	80066062	80066052(2)
SHELL DIAMETER,mm		324	406	406	406	406	406	406	406	324
TOTAL LENGTH, mm		2697	2744	2744	2737	2737	2737	2737	2737	2697
WATER HOLDING VOLUME, Liters		113.5	221.7	221.7	206.5	206.5	206.5	184.4	184.4	227
WATER IN/OUT PIPE DIA. (mm/in)		150/6	200/8	200/8	200/8	200/8	200/8	200/8	200/8	150/6
ECONOMIZER										
PART NUMBER.		NA	NA	80051633(2)	NA	80051633(2)	80051633(2)	80051633(3)	NA	NA
EXPANSION DEVICE		NA	NA	T.E.V.	NA	T.E.V.	T.E.V.	T.E.V.	NA	NA
GENERAL										
NUMBER OF REFRIGERANT CIRCUITS		2	2	2	3	3	3	3	3	4
REFRIGERANT CHARGE, kgs/comp (comp1/2)		44	44	48	35	39/35	41/38	41/38	44	38/35
SOUND PRESSURE LEVEL,Dba (3m/5m/10m)		78.6/75.1/69.8	78.9/75.4/70.1	78.9/75.4/70.1	77.1/73.6/68.3	77.1/73.6/68.3	80.2/76.7/71.4	80.2/76.7/71.4	80.4/76.9/71.6	80.1/76.6/71.4
OPERATING/SHIPPING Wt, kgs		4675/4562	5277/5055	5423/5201	6797/6591	6920/6714	7007/6801	7041/6857	7051/6867	9130/8903

Notes:

1-ALL COMPRESSORS WITH SLIDER CONTROL VALVE UNLOADING
2-ALL COMPRESSORS OPERATE AT 2900 RPM @ 50Hz
3-COOLER VENT AND DRAIN SIZE ARE 1/2" MPT
4-ALL COOLERS ARE SINGLE FACE REFRIGERANT CONNECTION.
5-SOUND PRESSURE LEVEL ± 2 dBA

PHYSICAL DATA

UNIT SIZE		ASQ230B	ASQ240B	ASQ250B	ASQ260B	ASQ270B	ASQ280B	ASQ300B	ASQ320B
COMPRESSOR									
PART NUMBER (380/415V-3ph-50Hz)		80068321	80068324(1) 80068321(3)	80068324(2) 80068321(2)	80068324(2) 80068321(2)	80068324	80068324	80068318(4) 80068315(2)	80068318
NUMBER OF COMPRESSORS		4	4	4	4	4	4	6	6
OIL CHARGE/COMPRESSOR (liters)		22	22	22	22	22	22	22/15	22
CAPACITY CONTROL RANGE (STEPLESS)		100-12.5						100-8.3	
MOTOR OVERLOAD PROTECTION (INTERNAL)		**ELECTRONIC**							
OIL LUBRICATION		**INJECTION**							
TOTAL CRANKCASE HEATER WATTS		1200	1200	1200	1200	1200	1200	1600	1800
REFRIGERANT		**R-134a**							
EXPANSION VALVE		**ELECTRONIC EXPANSION VALVE**							
CONTROL VOLTAGE		**220V-1Ph-50Hz**							
AIRCOOLED CONDENSER									
CONDENSER COIL	Tube Dia.-Rows-FPI	3/8-3-14	3/8-4+3-14	3/8-4-14	3/8-4-14	3/8-4-14	3/8-4-14	3/8-4+3-14	3/8-4-14
	Total face area, Sq. ft.	304	304	304	304	304	304	430.7	430.7
AIRFLOW, CFM		166240	163616	156192	156192	156192	156192	194004	191160
NUMBER OF FANS/FAN DIA; mm		16/800	16/800	16/800	16/800	16/800	16/800	18/800	18/800
FAN MOTOR RPM @ 380-3-50		860	860	860	860	860	860	860	860
COOLER									
PART NUMBER		80066052(2)	80066052(2)	80066052(2)	80066055(2)	80066055(2)	80066055(2)	80066059(2)	80066059(2)
SHELL DIAMETER,mm		324	324	324	406	406	406	406	406
TOTAL LENGTH, mm		2697	2697	2697	2744	2744	2744	2737	2737
WATER HOLDING VOLUME, Liters		227	227	227	443.4	443.4	443.4	413	413
WATER IN/OUT PIPE DIA. (mm/in)		150/6	150/6	150/6	200/8	200/8	200/8	200/8	200/8
ECONOMIZER									
PART NUMBER.		NA	NA	NA	NA	NA	80051633(2)	80051633(2)	80051633(2)
EXPANSION DEVICE		NA	NA	NA	NA	NA	T.E.V.	T.E.V.	T.E.V.
GENERAL									
NUMBER OF REFRIGERANT CIRCUITS		4	4	4	4	4	4	6	6
REFRIGERANT CHARGE, kgs/comp (comp1/2)		38	44/38	44/38	44/38	44	48/44	35/30	39/35
SOUND PRESSURE LEVEL,Dba (3m/5m/10m)		81.4/77.9/72.6	81.5/77.9/72.7	81.5/77.9/72.7	81.5/77.9/72.7	81.6/78.1/72.8	81.6/78.1/72.8	79.4/75.8/70.6	79.4/75.8/70.6
OPERATING/SHIPPING Wt, kgs		9159/8932	9227/9000	9394/9167	9986/9543	10021/9578	10052/9609	13088/12675	13242/12829

Notes:

1-ALL COMPRESSORS WITH SLIDER CONTROL VALVE UNLOADING

2-ALL COMPRESSORS OPERATE AT 2900 RPM @ 50Hz

3-COOLER VENT AND DRAIN SIZE ARE 1/2" MPT

4-ALL COOLERS ARE SINGLE FACE REFRIGERANT CONNECTION.

5-SOUND PRESSURE LEVEL ± 2 dBA

PHYSICAL DATA

UNIT SIZE		ASQ330B	ASQ340B	ASQ350B	ASQ360B	ASQ380B	ASQ400B	ASQ420B	ASQ440B
COMPRESSOR									
PART NUMBER (380/415V-3ph-50Hz)		80068318	80068321	80068321	80068321	80068324(4) 80068321(2)	80068324	80068324	80068324
NUMBER OF COMPRESSORS		6	6	6	6	6	6	6	6
OIL CHARGE/COMPRESSOR (liters)		22	22	22	22	22	22	22	22
CAPACITY CONTROL RANGE (STEPLESS)		100-8.3							
MOTOR OVERLOAD PROTECTION (INTERNAL)		**ELECTRONIC**							
OIL LUBRICATION		**INJECTION**							
TOTAL CRANKCASE HEATER WATTS		1800	1800	1800	1800	1800	1800	1800	1800
REFRIGERANT		**R-134a**							
EXPANSION VALVE		**ELECTRONIC EXPANSION VALVE**							
CONTROL VOLTAGE		**220V-1Ph-50Hz**							
AIRCOOLED CONDENSER									
CONDENSER COIL	Tube Dia.-Rows-FPI	3/8-4-14	3/8-4-14	3/8-4-14	3/8-4-14	3/8-4-14	3/8-4-14	3/8-4-14	3/8-4-14
	Total face area, Sq. ft.	430.7	430.7	521.3	521.3	521.3	521.3	521.3	521.3
AIRFLOW, CFM		191160	191160	232936	232936	232936	232936	232936	232936
NUMBER OF FANS/FAN DIA; mm		18/800	18/800	22/800	22/800	22/800	22/800	22/800	22/800
FAN MOTOR RPM @ 380-3-50		860	860	860	860	860	860	860	860
COOLER									
PART NUMBER		80066059(2)	80066059(2)	80066059(2)	80066059(2)	80066062(2)	80066062(2)	80066068(2)	80066068(2)
SHELL DIAMETER,mm		406	406	406	406	406	406	457	457
TOTAL LENGTH, mm		2737	2737	2737	2737	2737	2737	2790	2790
WATER HOLDING VOLUME, Liters		413	413	413	413	368.8	368.8	504	504
WATER IN/OUT PIPE DIA. (mm/in)		200/8	200/8	200/8	200/8	200/8	200/8	200/8	200/8
ECONOMIZER									
PART NUMBER.		80051633(3)	NA	NA	80051633(3)	NA	NA	80051633(3)	80051633(6)
EXPANSION DEVICE		T.E.V.	NA	NA	T.E.V.	NA	NA	T.E.V.	T.E.V.
GENERAL									
NUMBER OF REFRIGERANT CIRCUITS		6	6	6	6	6	6	6	6
REFRIGERANT CHARGE, kgs/comp (comp1/2)		39/35	38	38	41/38	44/38	44	48/44	48
SOUND PRESSURE LEVEL,Dba (3m/5m/10m)		79.4/75.8/70.6	82.9/79.3/74.1	83.1/79.5/74.3	83.1/79.5/74.3	83.2/79.7/74.4	83.3/79.8/74.5	83.3/79.8/74.5	83.3/79.8/74.5
OPERATING/SHIPPING Wt, kgs		13257/12844	13297/12884	13859/13446	13902/13489	13971/13602	14006/13637	14597/14093	14643/14139

Notes:

1-ALL COMPRESSORS WITH SLIDER CONTROL VALVE UNLOADING

2-ALL COMPRESSORS OPERATE AT 2900 RPM @ 50Hz

3-COOLER VENT AND DRAIN SIZE ARE 1/2" MPT

4-ALL COOLERS ARE SINGLE FACE REFRIGERANT CONNECTION.

5-SOUND PRESSURE LEVEL ± 2 dBA

MICROPROCESSOR CONTROLLER

The microprocessor controller works on a state of art microprocessor technology. This controller monitors analog and digital inputs to achieve precise control & safety functions of the unit.

The Software works on the Proportional Integral Derivative (PID) algorithm for precise control logic.
The simple to use push button keyboard allows accessing to the operating conditions, control set points & alarm history that are clearly displayed on a multi-line back illuminated LCD panel.

An easy to install **serial port/ modem option** allows remote monitoring of the operating parameters. With corresponding windows software, the system allows data to be viewed in tabular or graphic format as well as interact with system set up. This chiller controller is compatible with Building Management System (BMS) "BAC NET/ MODBUS" protocols through corresponding optional gateway interfaces.

It is also compatible with GSM protocol through GSM optional gateway that sends up to 3 mobile phones SMS messages whenever alarm takes place, indicating the type of alarm, the corresponding compressor, the related chiller and which location.

The microprocessor consists of the following hardware:

1. User Interface Board: Provided with simple to use push button keyboard and menu driven software to access operating conditions, control set points & alarm history clearly displayed on the LCD panel.
2. Main Board: This control up to two (2) compressor system.
3. Auxiliary Boards: Required for controlling an additional two (2) or more compressors.
4. Remote Monitoring System [Optional]: The micro controller is complete with all hardware and software necessary to remotely monitor and control the chiller unit.

Display Information:

In the normal operating mode the 20 x 4 characters LCD panel display the system status, the temperature of the water inlet & outlet, the set point, run time of the compressor & the alarm history.

Easily accessible measurements for each circuit include the following:
- Suction and discharge temperatures
- Suction, discharge and oil pressures
- Water inlet/ outlet temperatures
- Compressor status
- Fan status
- Liquid line solenoid status
- Unit/ Compressor run time

The control temperature is continuously displayed on the 3 Digit 7 segments LED Display. The 3 LED lights indicate the **Power ON, Menu adjustment and Fault.**

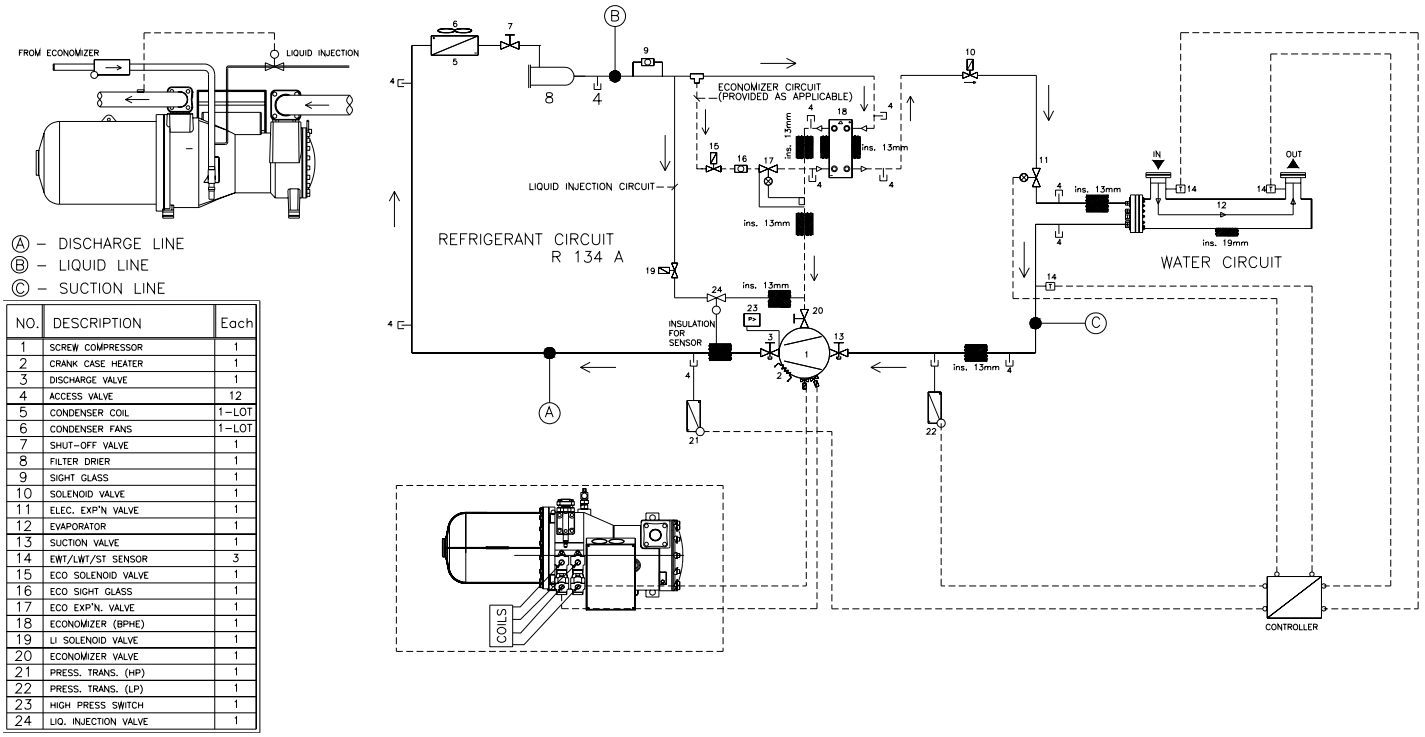
System protection:

The following system protection is provided to ensure system reliability:
- Compressor winding overheating
- Low suction pressure
- High discharge pressure
- Freeze protection.
- Low oil pressure
- Sensor error
- Time delay – anti recycle time for compressor
- Serial communication error.

BASIC REFRIGERANT FLOW AND PROCESS & INS. DIAGRAM

These chillers work on the concept of Vapor Compression Refrigeration. At the start of operation cycle, the water (or other liquid) flows through the water piping system, the flow switch contact is made, and if the controller calls for cooling and all safety devices are closed, the compressor will start.

The compressor raises the pressure of the refrigerant and it is pumped to the condenser. Since this (high side) refrigerant temperature is higher than the temperature of the air being passed through the condenser, heat flows from the hot refrigerant gas to the condenser air. Thus, heat is absorbed by the condenser air from the refrigerant and the high pressure refrigerant gas changes its phase to high pressure liquid. The high pressure liquid refrigerant then flows through a filter drier, sight glass/moisture indicator, economizer (if provided) and then liquid line solenoid valve (which should be open now). The system pressure then forces the liquid into an expansion valve which causes a large pressure drop and also meters the liquid refrigerant through the evaporator/cooler. The refrigerant then passes through the tubes inside the cooler while water flows over these tubes, thus heat transfers from the higher temperature water to the lower temperature refrigerant. The water gets chilled and the liquid refrigerant evaporates into a gas. The refrigerant is returned back to the suction side (low side) of the compressor as a low pressure gas and is then ready to be recycled again through the compressor.



NO.	DESCRIPTION	Each
1	SCREW COMPRESSOR	1
2	CRANK CASE HEATER	1
3	DISCHARGE VALVE	1
4	ACCESS VALVE	12
5	CONDENSER COIL	1–LOT
6	CONDENSER FANS	1–LOT
7	SHUT–OFF VALVE	1
8	FILTER DRIER	1
9	SIGHT GLASS	1
10	SOLENOID VALVE	1
11	ELEC. EXP'N VALVE	1
12	EVAPORATOR	1
13	SUCTION VALVE	1
14	EWT/LWT/ST SENSOR	3
15	ECO SOLENOID VALVE	1
16	ECO SIGHT GLASS	1
17	ECO EXP'N. VALVE	1
18	ECONOMIZER (BPHE)	1
19	LI SOLENOID VALVE	1
20	ECONOMIZER VALVE	1
21	PRESS. TRANS. (HP)	1
22	PRESS. TRANS. (LP)	1
23	HIGH PRESS SWITCH	1
24	LIQ. INJECTION VALVE	1

Notes:

1. This P & I diagram illustrate a single refrigeration circuit. Total number of these circuits in a particular chiller shall be as many as the number of compressors provided in that chiller.
2. This P & I applicable for a chiller with standard features. For chillers provided with optional features like pressure gauges, hot gas bypass system, cooler heater, etc. suitable changes in this diagram should be envisaged.
3. If 'Economizer' is provided in a refrigerant circuit, it optimizes the system capacity by further sub cooling the high pressure liquid refrigerant which increases its thermodynamic efficiency. This is accomplished by a refrigerant to refrigerant brazed plate heat exchanger in which a portion of the high pressure liquid refrigerant is vaporized thereby sub cooling the remaining liquid refrigerant. Although this has little effect on the suction capacity of the compressor but the effective refrigerating capacity of the compressor is boosted by the increased heat absorption capacity of the liquid entering the evaporator/cooler.
4. The 'Liquid Injection Circuit' is provided to allow refrigerant injection for oil cooling. The solenoid valve and liquid injection valve provided in this circuit open in response to demand sensed by the discharge line temperature sensor (i.e. open when the refrigerant discharge temperature rises above the set point). The liquid injection valve is required/ provided in the LI circuit when the refrigeration circuit includes an economizer. In case the refrigeration circuit does not have an economizer, the liquid injection valve is not required/ provided and the process of liquid injection is accomplished by the LI solenoid valve alone in conjunction with the chiller controller.

HANDLING AND STORAGE

INSPECTION

Upon delivery of equipment, it is important that the following inspection is performed in the presence of transporters and/or Zamil's representatives:

- Check all crates and cartons received against the Invoice / shipping papers to be sure they are complete.
- Check model numbers and electrical characteristics on the nameplates of the units delivered to determine if they are correct.
- Check the loose items/accessories, if supplied any (field installed items like spring isolators & flow switches), Check for freight damage, shortages or other discrepancies and note them on the delivery receipt before signing and receiving.

In the event that any damage is found, a damage claim should be immediately filed by the purchasers against the delivering carrier as all shipments are made at the buyer's risk. The same should be notified to the concerned Zamil Office immediately.

RIGGING INSTRUCTIONS

Each unit has been crafted and carefully tested at the factory where every precaution is taken to ensure that it reaches you in perfect condition. It is very important that the riggers and movers should use the same care and precaution in moving the equipment into place. Make sure that chains, slings, cables or other rigging equipment are employed so as to avoid damage to the units.

Before moving the units, ensure that the site is ready and suitable for installing the equipment and is capable of supporting the weight of units and all associated equipment.

These units are designed for lifting and overhead rigging. Based on weight and dimensions of the units, either rigging holes are provided in the base rail or lifting eyes extending from the sides of the base rail. These rigging holes or lifting eyes are centered around the unit center of gravity. For rigging the units, follow these instructions:

- For units with rigging holes in the base rail, insert **pipes** thru these holes to support the whole unit and lift using rigging slings and hooks or shackles as shown in Figure A below.
- For units with lifting eyes on the base rail, attach the **hooks** or **shackles** directly into them and lift using rigging slings as shown in Figures B & C below.
- Center of gravity is not unit centerline; ensure center of gravity aligns with main lifting point before lifting.
- Use spreader bars when rigging, to prevent slings from damaging the unit (as shown in Fig. A to C).

Units must only be lifted from the base and at the points provided.
All unit panels should be in place when rigging.
Extra care must be taken to avoid damage to the condenser coil.
Insert packing material between coils and slings as necessary.
Do not apply pressure to the unit's body.
Refrigerant piping should never be used as a foothold or handhold.
Never move the unit on roller or using a fork lift truck.

Lifting equipment must be capable of handling the unit weight with adequate safety factor. For details of unit weights and weight distribution refer to the Physical data and Load distribution Sections in this manual.

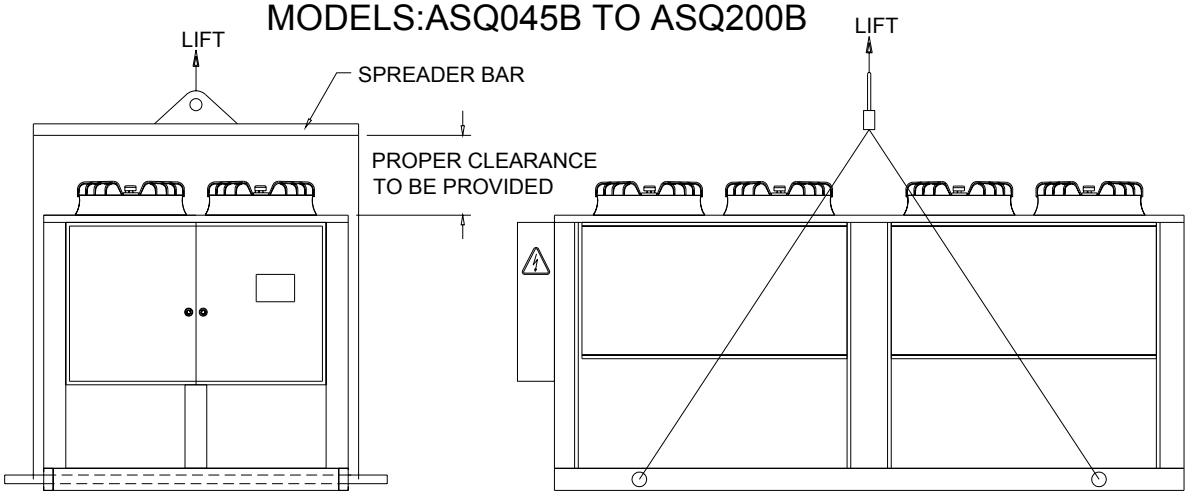


Figure A

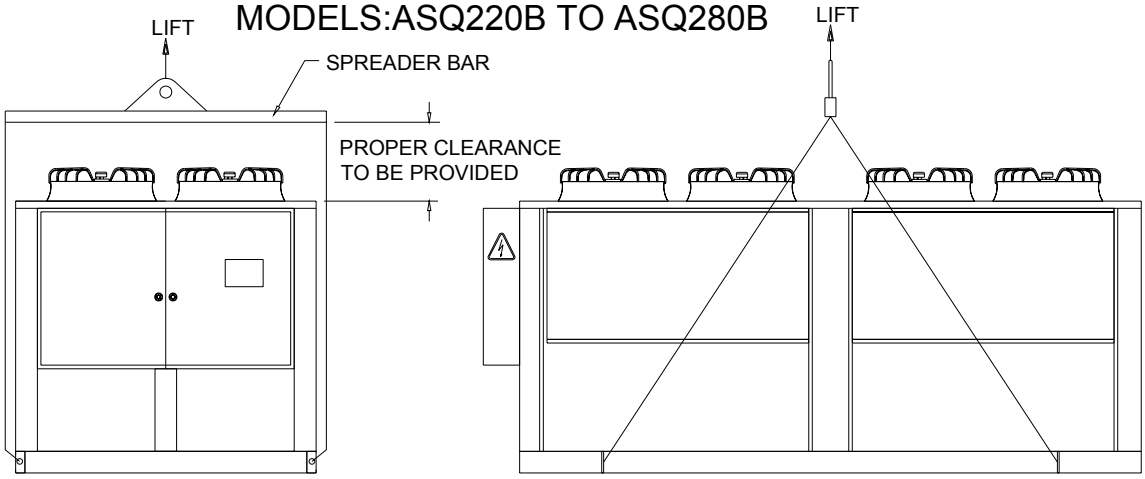


Figure B

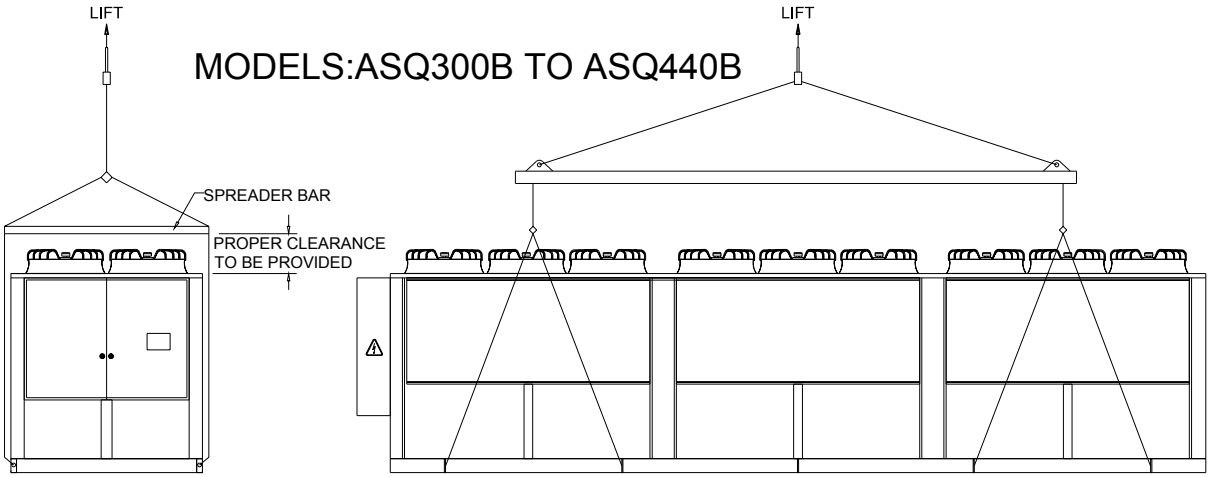


Figure C

STORAGE INSTRUCTIONS

If the unit is to be put into storage prior to installation, observe the following precautions:

- Store in a dry and clean place preferably sheltered or shaded area.
- Place the units on a flat solid surface so that the chiller base does not bend or sag.
- Protect equipment from physical damages, store in a location where there is minimal activity, in order to limit the risk of accidental physical damage.
- Condenser coils should be securely covered to protect the fins from damage and corrosion, particularly where the building work is in progress.
- Check that all openings, such as water connections, are securely capped.
- It is recommended that the items/accessories supplied loose and the control panel keys are deposited with a responsible person.
- It is recommended that the units are periodically inspected as a proactive measure.

INSTALLATION PROCEDURES

PRE-INSTALLATION GUIDELINES

These chillers are designed for outdoor installation and can be installed at ground level or on a suitable rooftop location. In order to achieve good operation, performance and trouble-free service, it is essential that the proposed installation location meets the following requirements:

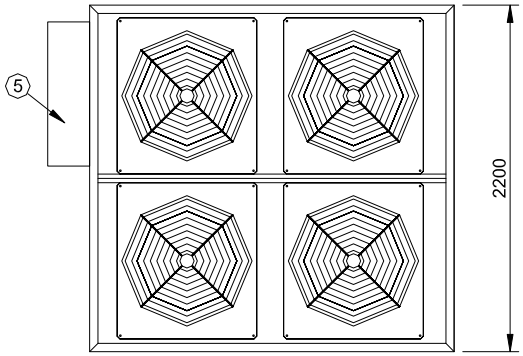
- The most important consideration while deciding upon the location of air cooled chillers is the provision for supply of adequate ambient air to the condenser and removal of heated discharge air from the condenser. This is accomplished by maintaining ***sufficient clearances which have been specified in this manual*** around the units and avoiding obstructions in the condenser air discharge area to prevent the possibility of warm air circulation. Further, the condenser fans are propeller type and are not recommended for use with ductwork or other hindrances in the condenser air stream. Where these requirements are not complied, the supply or discharge airflow restrictions or warm air recirculation will cause higher condensing temperatures resulting in poor unit operation, higher power consumption and possible eventual failure of equipment.
- The unit's longitudinal axis should be parallel to the prevailing wind direction in order to ensure a balanced air flow through the condenser coils. Consideration should also be given to the possibility of down-drafts caused by adjacent buildings, which may cause recirculation or uneven unit airflow. For locations where significant cross winds are expected, an enclosure of solid or louver type is recommended to prevent wind turbulence interfering with the unit airflow. When units are installed in an enclosure, the enclosure height should not exceed the height of the unit.
- The location should be selected for minimum sun exposure and away from hot air sources, steam, exhaust vents and sources of airborne chemicals that could attack the condenser coils and steel parts of the unit. Avoid locations where the sound output and air discharge from the units may be objectionable.
- If the location is an area which is accessible to unauthorized persons, steps must be taken to prevent access to the unit by means of a protective fence. This will help to prevent the possibility of vandalism, accidental damage or possible harm caused by unauthorized removal of panels or protective guards exposing rotating or high voltage components.
- The clearance requirements prescribed in this manual are necessary to maintain good airflow and provide access for unit operation and maintenance. However, it is also necessary to consider access requirements based on practical considerations for servicing, cleaning and replacing large components.
- The unit must be installed on a ONE-PIECE, FLAT and LEVELLED {within ½" (13 mm) over its length and width} CONCRETE BASE that extends fully to support the unit. The carrying or supporting structure should be capable of handling complete operating weight of the unit as given in the ***Physical Data tables in this manual***.
- For ground level installations, it must be ensured that the concrete base is stable and does not settle or dislocate upon installation of the unit which can strain the refrigerant lines resulting in leaks and may also cause compressor oil return problems. It is recommended that the concrete slab is provided with appropriate footings. The slab should not be connected to the main building foundation to avoid noise and vibration transmission.
- For rooftop installations, choose a place with adequate structural strength to safely support the entire operating weight of the unit. The unit shall be mounted on a concrete slab similar to ground installations. The roof must be reinforced for supporting the individual point loads at the mounting isolator locations. It must be checked and ensured that the concrete base is perfectly horizontal and levelled, especially if the roof has been pitched to aid in water removal. It should be determined prior to installation if any special treatment is required to assure a levelled installation else it could lead to the above mentioned problems.

SPACE REQUIREMENTS

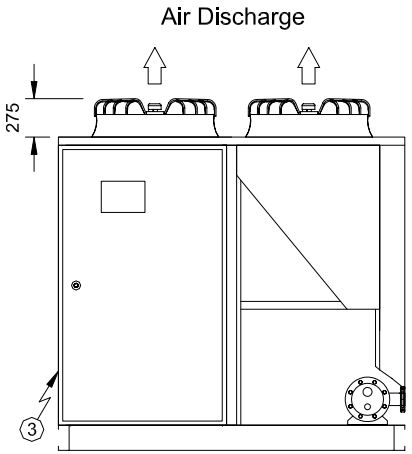
Dimensional drawings for all chiller models are given in the following pages. In order to ascertain space requirement for an installation, refer to the respective chiller drawing:

ASQ045B,ASQ050B,ASQ055B,ASQ060B & ASQ070B

① WATER IN
② WATER OUT
③ ELECTRIC POWER INLET
④ LIFTING POINTS
⑤ ELECTRICAL CONTROL BOX



TOP VIEW



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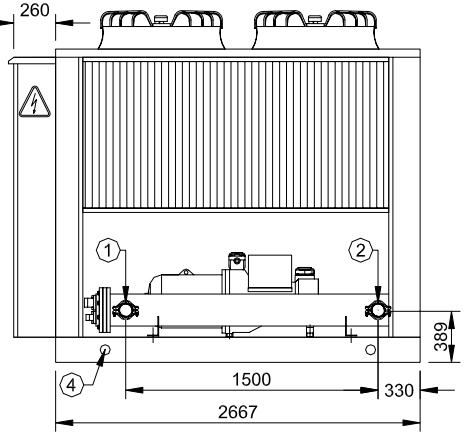
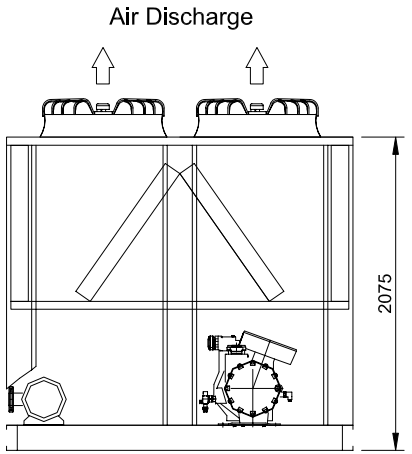


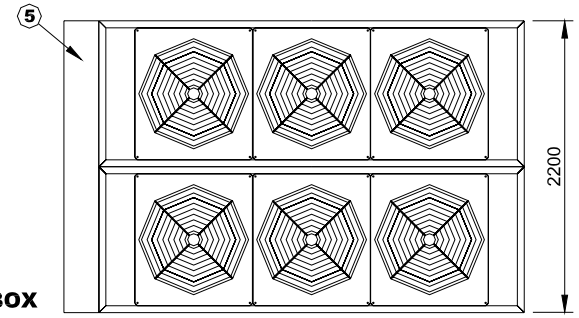
FRONT VIEW



END VIEW

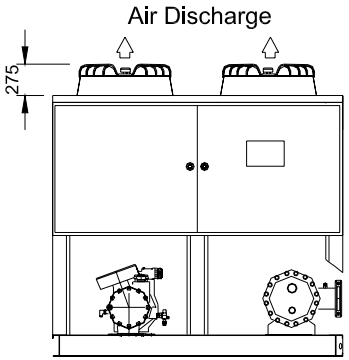
ASQ080B,ASQ090B & ASQ100B

① WATER IN
② WATER OUT
③ ELECTRIC POWER INLET
④ LIFTING POINTS
⑤ ELECTRICAL CONTROL BOX



TOP VIEW

Model	A	B	C
ASQ80B	1500	330	389
ASQ090B & ASQ100B	1730	360	414



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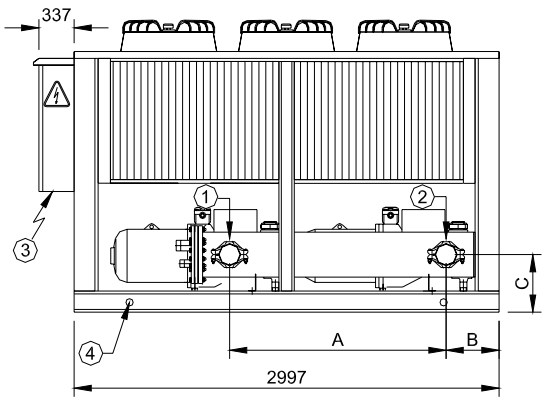
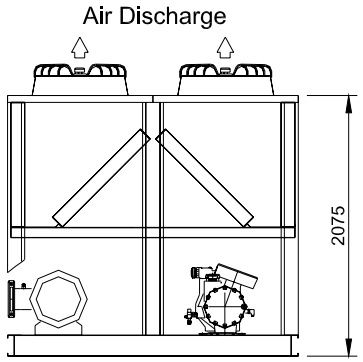


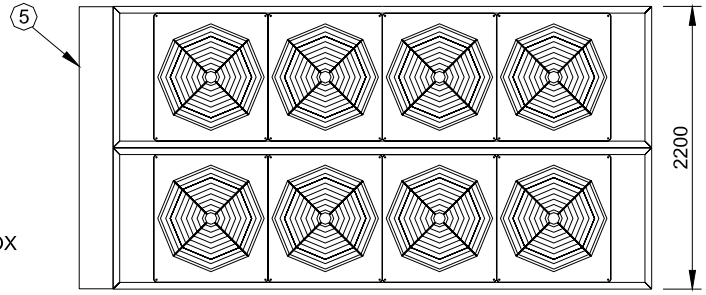
FRONT VIEW



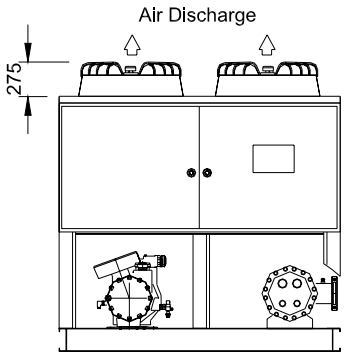
END VIEW

ASQ115B & ASQ130B

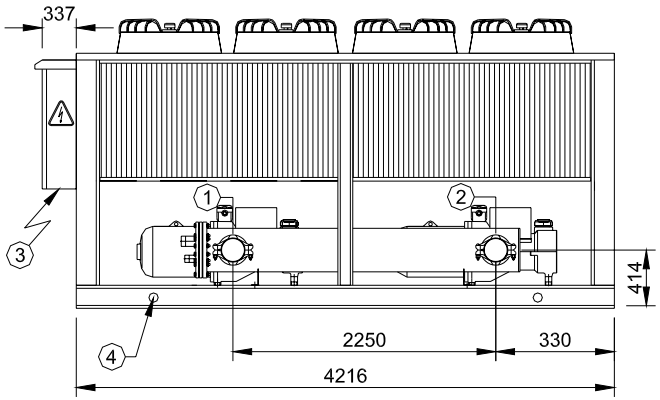
① WATER IN
② WATER OUT
③ ELECTRIC POWER INLET
④ LIFTING POINTS
⑤ ELECTRICAL CONTROL BOX



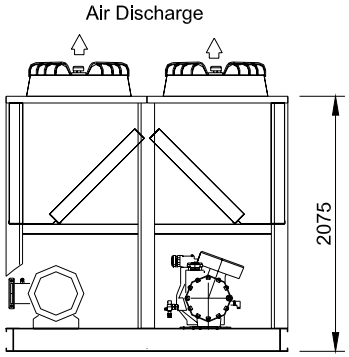
TOP VIEW



END VIEW



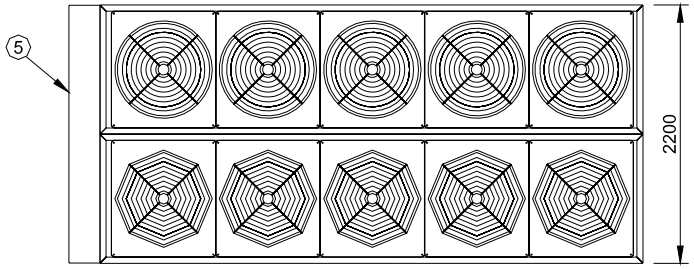
FRONT VIEW



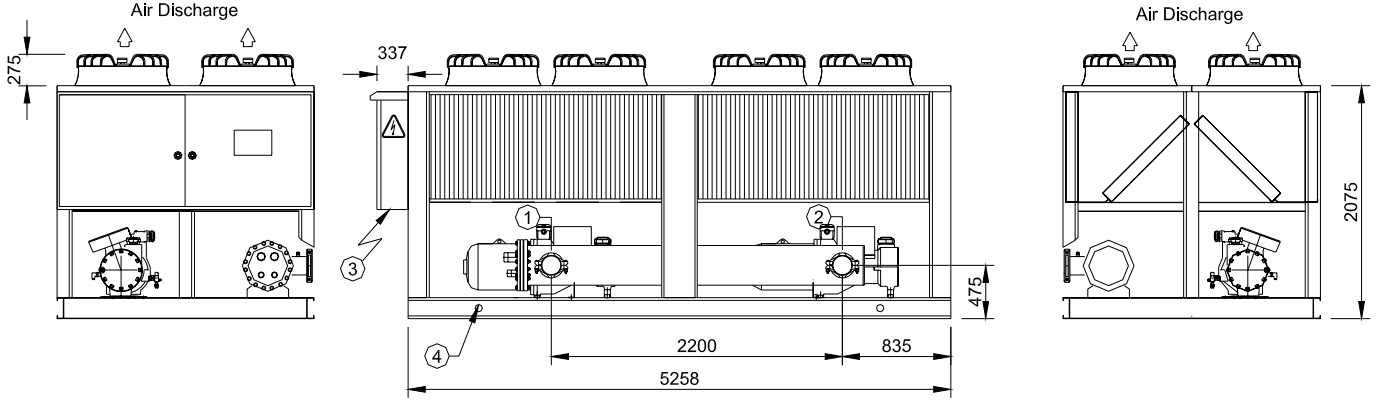
END VIEW

ASQ140B& ASQ150B

① WATER IN
② WATER OUT
③ ELECTRIC POWER INLET
④ LIFTING POINTS
⑤ ELECTRICAL CONTROL BOX



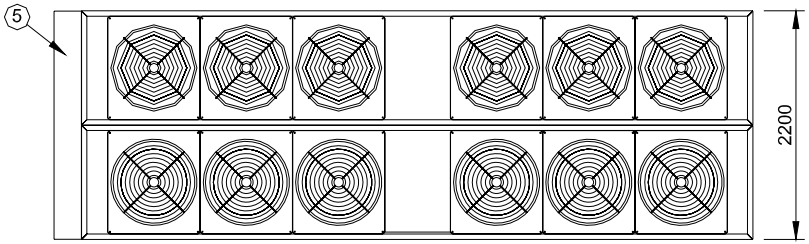
TOP VIEW



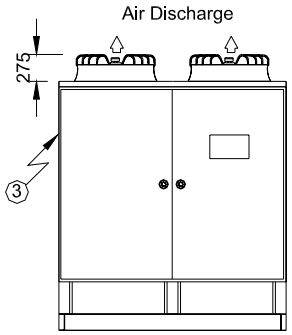
END VIEW **FRONT VIEW** **END VIEW**

ASQ160B,ASQ170B,ASQ180B,ASQ190B & ASQ200B

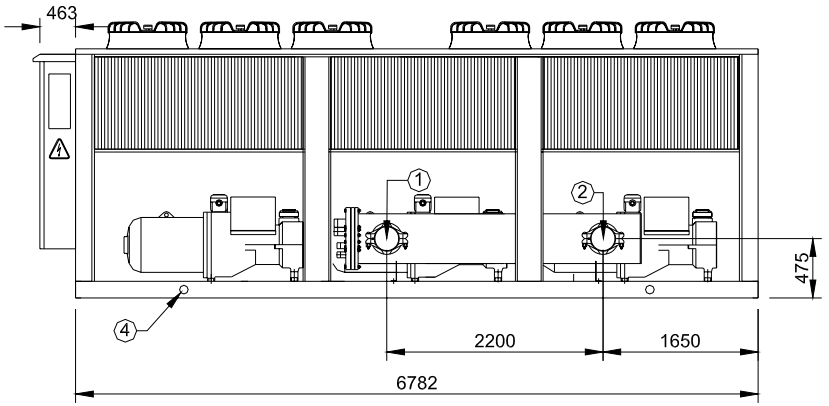
1. WATER IN
2. WATER OUT
3. ELECTRIC POWER INLET
4. LIFTING POINTS
5. ELECTRICAL CONTROL BOX



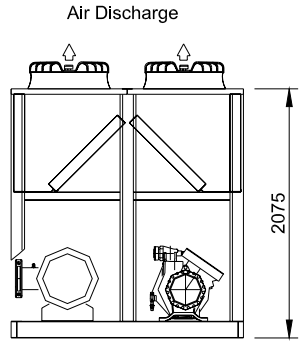
TOP VIEW



END VIEW



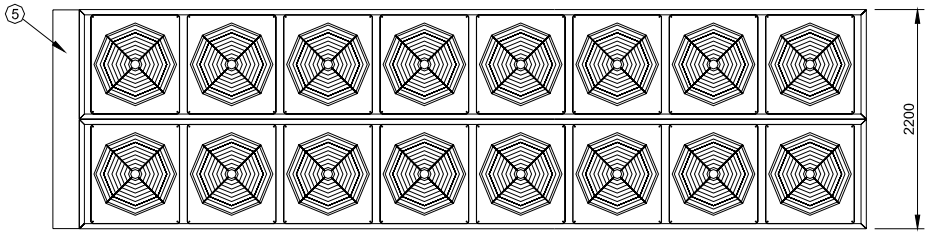
FRONT VIEW



END VIEW

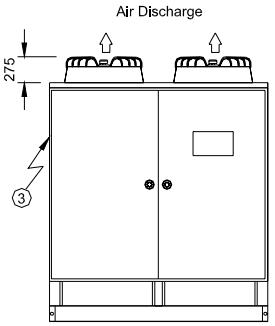
ASQ 220B,ASQ230B,ASQ240B,ASQ250B,ASQ260B,ASQ270B & ASQ280B

① WATER IN
② WATER OUT
③ ELECTRIC POWER INLET
④ LIFTING POINTS
⑤ ELECTRICAL CONTROL BOX

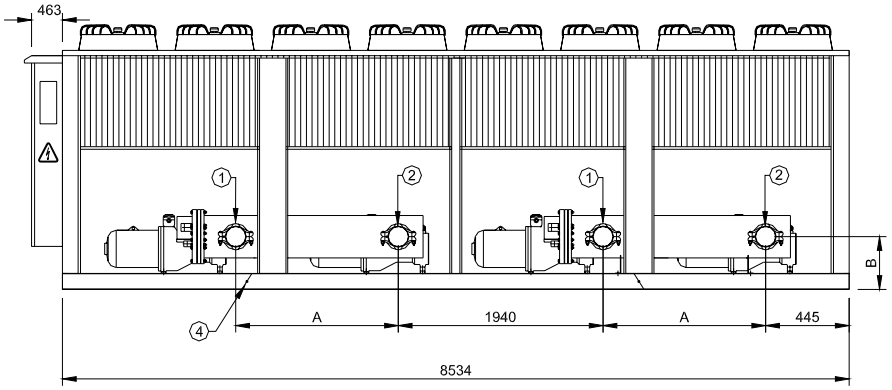


Model	A	B
ASQ220B,ASQ230B,ASQ240B & ASQ250B	2250	422
ASQ260B,ASQ270B & ASQ280B	2200	483

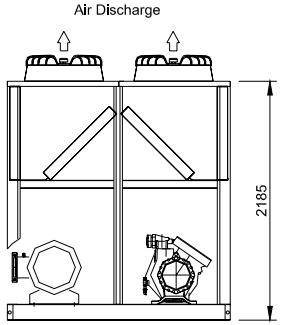
TOP VIEW



END VIEW



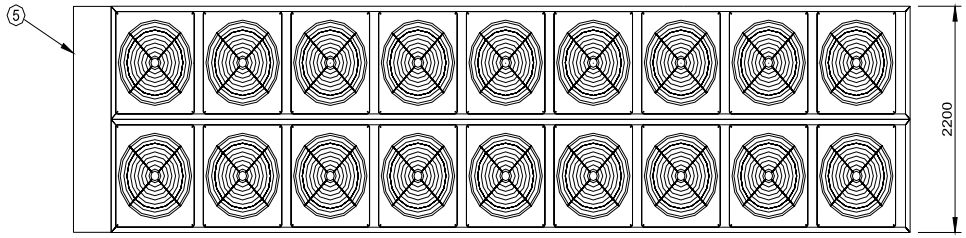
FRONT VIEW



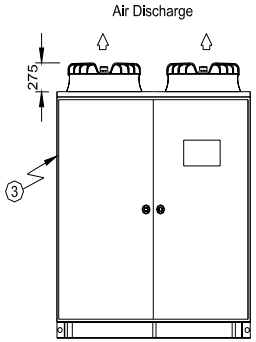
END VIEW

ASQ300B,ASQ320B,ASQ330B & ASQ340B

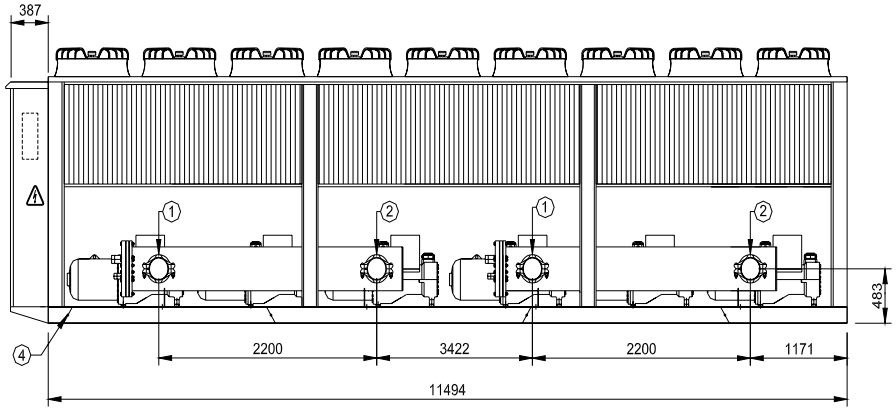
① WATER IN
② WATER OUT
③ ELECTRIC POWER INLET
④ LIFTING POINTS
⑤ ELECTRICAL CONTROL BOX



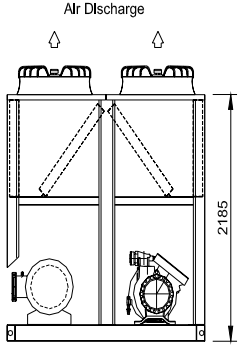
TOP VIEW



END VIEW



FRONT VIEW

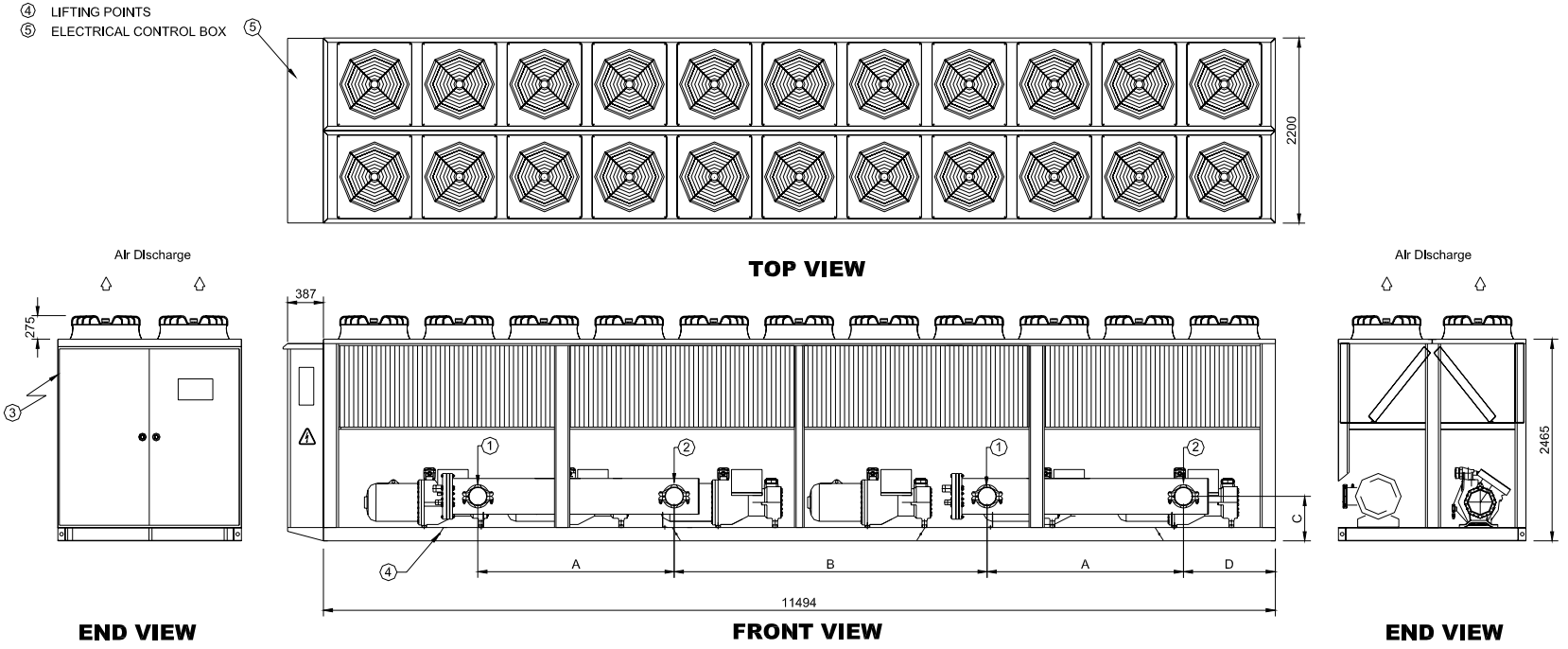


END VIEW

ASQ350B,ASQ360B,ASQ380B,ASQ400B,ASQ420B & ASQ440B

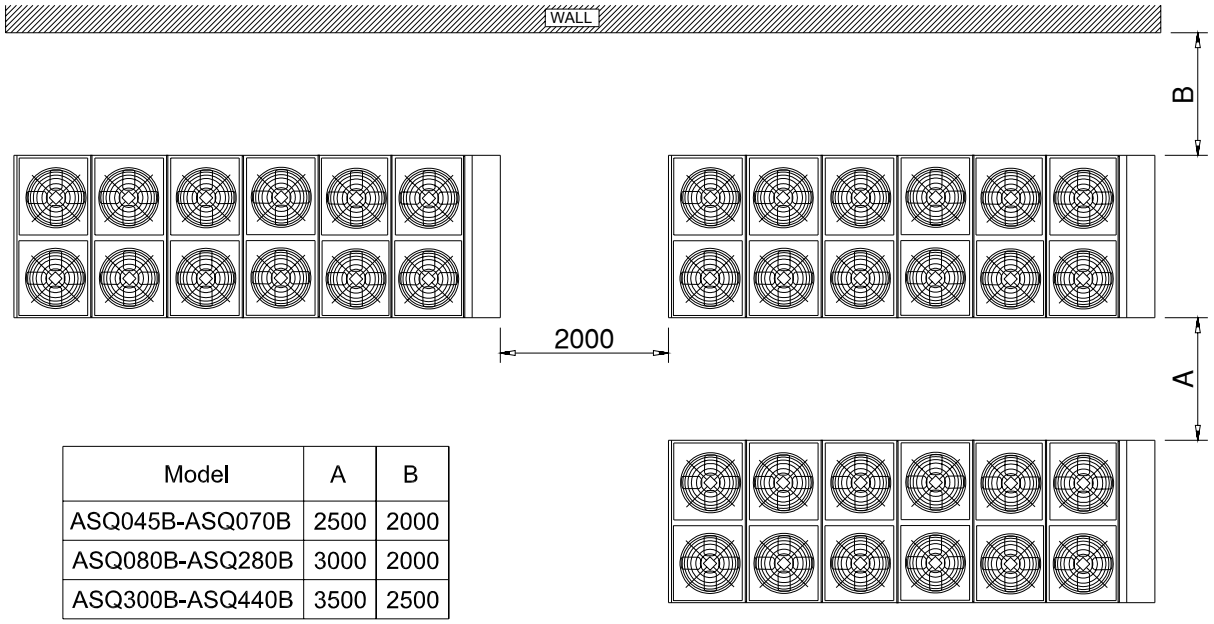
Model	A	B	C	D
ASQ350B,ASQ360B,ASQ380B & ASQ400B	2200	3420	483	1241
ASQ420B & ASQ440B	2130	3490	510	1241

① WATER IN
② WATER OUT
③ ELECTRIC POWER INLET
④ LIFTING POINTS
⑤ ELECTRICAL CONTROL BOX



CLEARANCES

The installation clearances to be maintained for the various unit models are as follows:



Model	A	B
ASQ045B-ASQ070B	2500	2000
ASQ080B-ASQ280B	3000	2000
ASQ300B-ASQ440B	3500	2500

FIGURE 1
STRAIGHT WALL

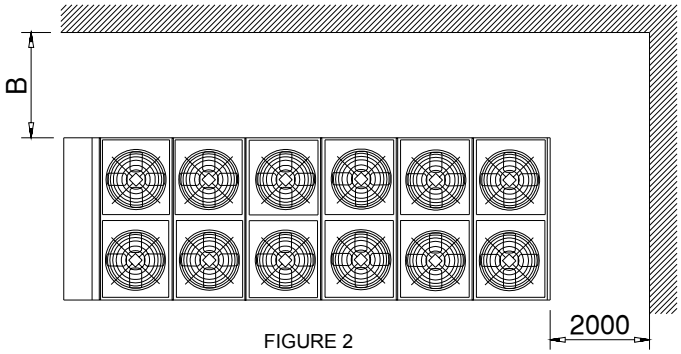


FIGURE 2
CORNER WALL

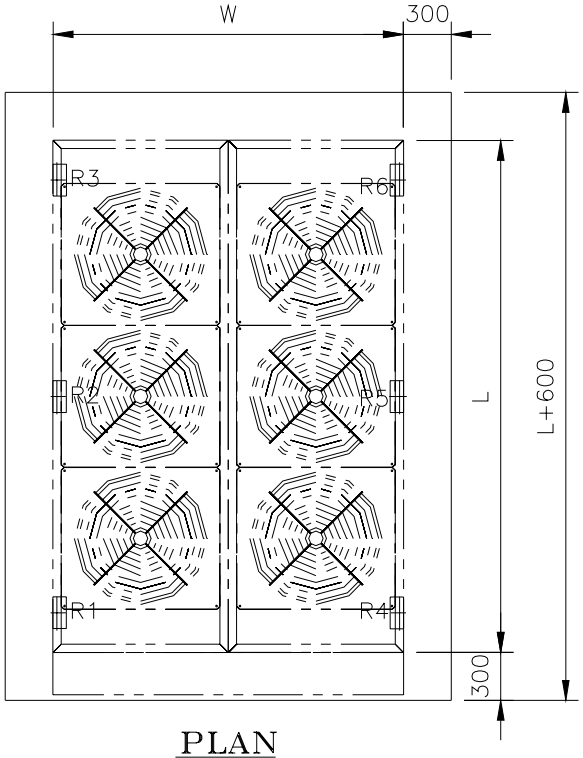
Notes:

1. All above dimensions are in mm.
2. PIT INSTALLATION: If unit is installed in special pit, please observe the same tolerance for walls. Pit heights should not exceed Chiller height.

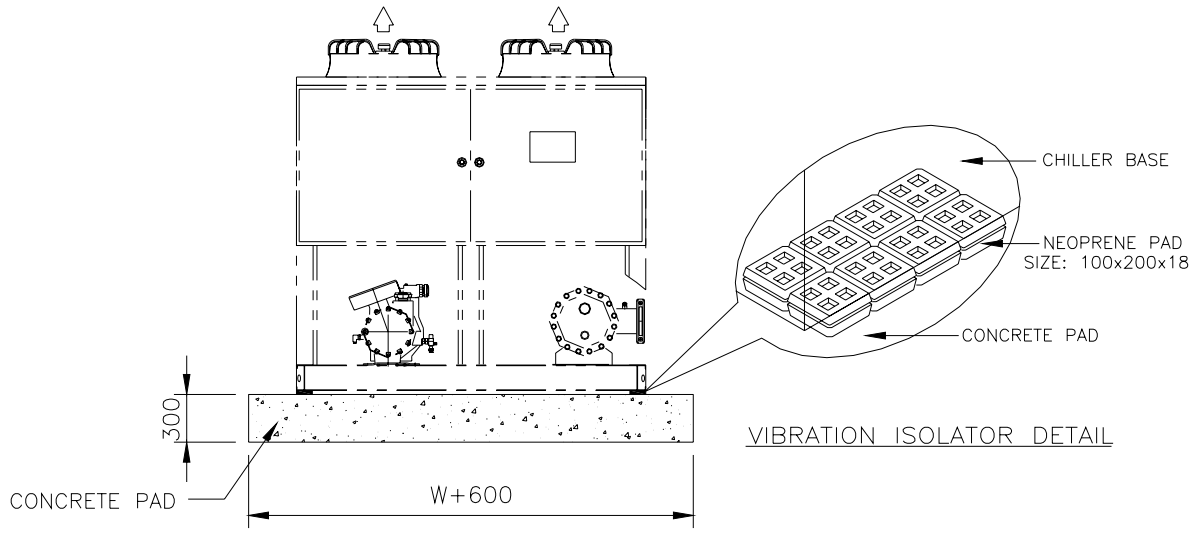
VIBRATION ISOLATION AND SCHEMATIC MOUNTING LAYOUTS

Vibration isolators are necessary for installing these chillers in order to minimize the transmission of vibrations. The two types of vibration isolators generally utilized for mounting these units are Neoprene Pads and Spring Isolators. Neoprene Pads are recommended for ground level normal installations jobs where vibration isolation is not critical and job costs must be kept to a minimum. Spring Isolators are recommended for ground level installations which are noise-sensitive areas or exposed to wind loads and **all roof top installations.** For extremely noise and vibration sensitive areas, follow the recommendations of structural and acoustical consultants.

SCHEMATIC MOUNTING LAYOUT
WITH NEOPRENE PAD VIBRATION ISOLATORS



PLAN



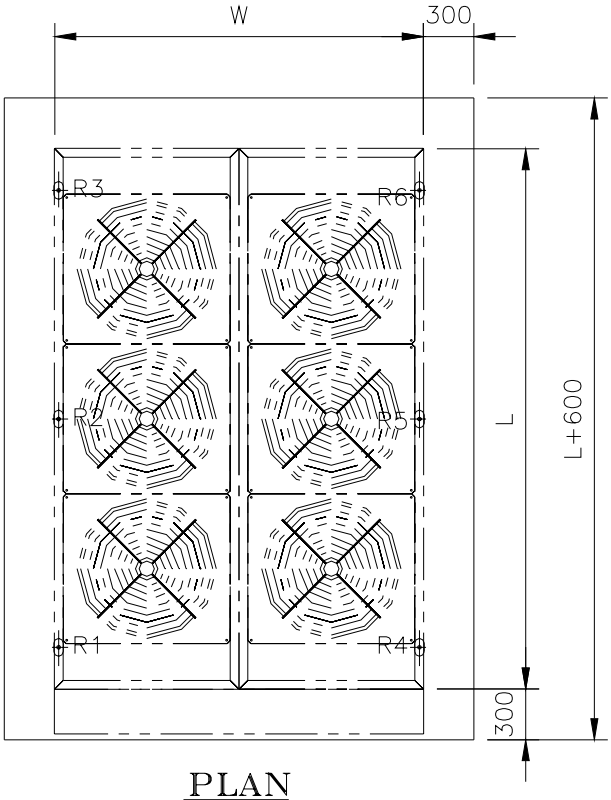
VIBRATION ISOLATOR DETAIL

ELEVATION

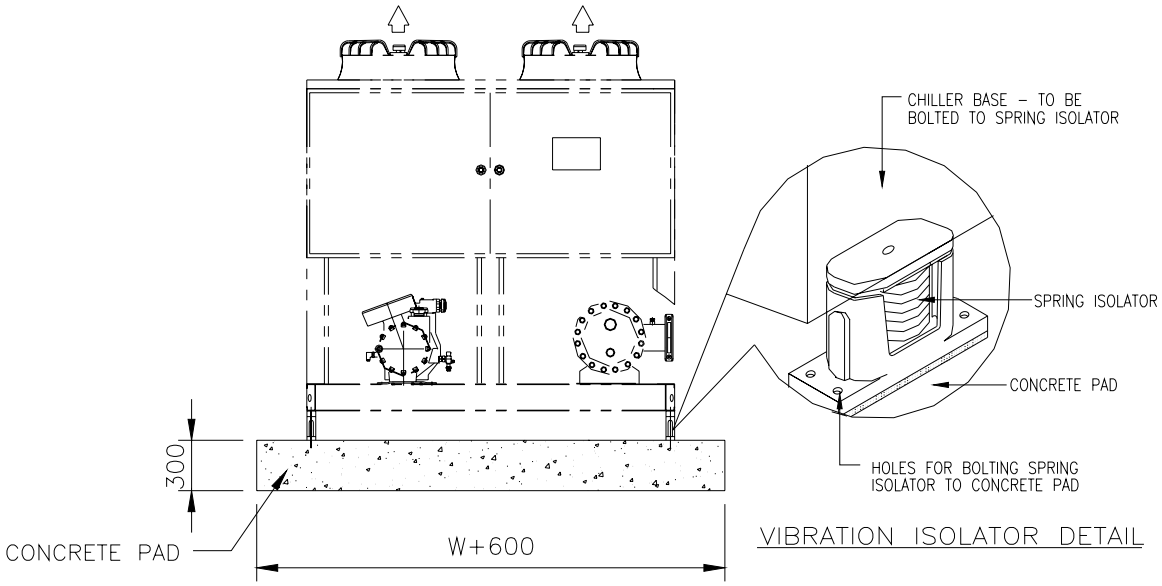
NOTES:

1. ALL DIMENSIONS ARE GIVEN IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
2. COMMERCIALLY AVAILABLE NEOPRENE PAD SINGLE MODULE SIZE: 50x50x18THK. TOTAL NO. OF MODULES REQUIRED AT EACH POINT SHOULD BE SELECTED BASED ON THE RESPECTIVE POINT LOAD AND CONSIDERING THAT EACH MODULE LOADING DOES NOT EXCEED 80 KGS. (Eg :– FOR A POINT LOAD OF 861 Kgs. THE NO. OF MODULES REQUIRED WILL BE 861/80=10.76. IN THIS CASE, 12 MODULES SHOULD BE PROVIDED. OVERALL PAD SIZE SHOULD BE 100x300x18.
3. NEOPRENE PADS SHOULD BE PROVIDED AT THEIR CORRECT LOCATIONS BASED ON MOUNTING POINTS FOR THE RESPECTIVE CHILLER MODEL.

SCHEMATIC MOUNTING LAYOUT
WITH SPRING TYPE VIBRATION ISOLATORS



PLAN



VIBRATION ISOLATOR DETAIL

ELEVATION

NOTES:

1. ALL DIMENSIONS ARE GIVEN IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
2. SPRING TYPE VIBRATION ISOLATORS SHOULD BE SUITABLY SELECTED AND PROVIDED AT THEIR CORRECT LOCATIONS BASED ON MOUNTING POINTS FOR THE RESPECTIVE CHILLER MODEL.

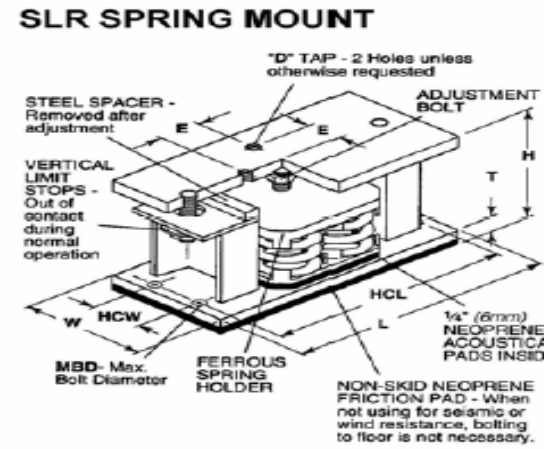
RECOMMENDATIONS FOR SPRING TYPE VIBRATION ISOLATOR SELECTION

The following types of spring isolators are recommended for various applications. Any of these spring isolators can be supplied by ZAMIL as optional items.

Standard Applications:

The SLR series vertically restrained spring isolation mounts are recommended as a noise and vibration isolator for chillers to reduce the transmission of noise and vibration into supporting structures.

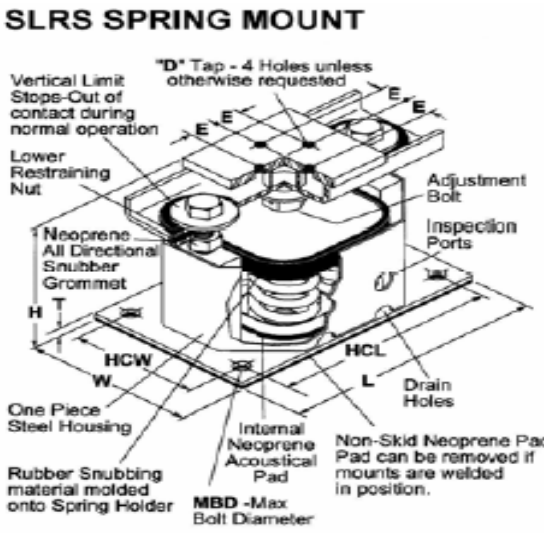
Operating static deflections are available up to 5" to compensate for long span flexible floor structures and maintain a high degree of noise and vibration isolation.


SLR SPRING MOUNT
"D" TAP - 2 Holes unless otherwise requested
STEEL SPACER - Removed after adjustment
ADJUSTMENT BOLT
VERTICAL LIMIT STOPS - Out of contact during normal operation
E
H
T
HCL
HCW
W
L
MBD- Max. Bolt Diameter
FERROUS SPRING HOLDER
NON-SKID NEOPRENE FRICTION PAD - When not using for seismic or wind resistance, bolting to floor is not necessary.

Seismic Applications:

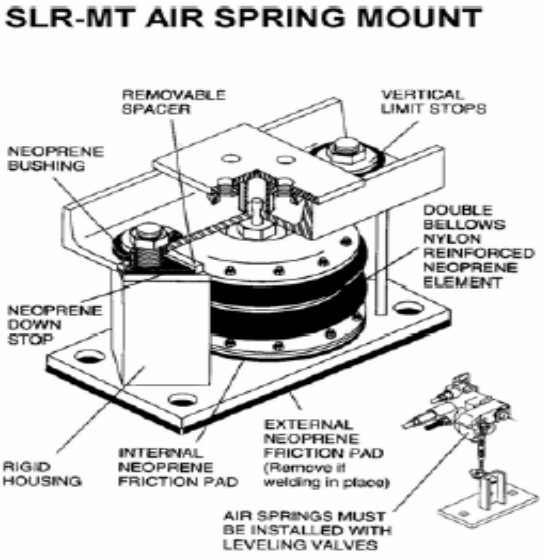
The SLRS series vertically restrained seismic spring isolation mounts are recommended as a noise and vibration isolator for chillers to reduce the transmission of noise and vibration into supporting structures in seismic zone applications where static G ratings in three planes are required.

Operating static deflections are available up to 5" to compensate for long span flexible floor structures and maintain a high degree of noise and vibration isolation.



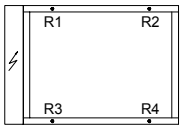
Critical and Noise Sensitive applications:

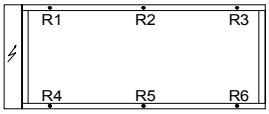
The SLR-MT vertically restrained air spring isolation mounts are recommended as a noise and vibration isolator for chillers to reduce the transmission of noise and vibration into supporting structures where the equipment are located in critical areas where noise transmission is a major worry or very high isolation efficiency is required.

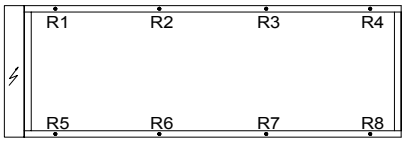

SLR-MT AIR SPRING MOUNT
REMOVABLE SPACER
VERTICAL LIMIT STOPS
NEOPRENE BUSHING
DOUBLE BELLOWS NYLON REINFORCED NEOPRENE ELEMENT
NEOPRENE DOWN STOP
EXTERNAL NEOPRENE FRICTION PAD (Remove if welding in place)
RIGID HOUSING
INTERNAL NEOPRENE FRICTION PAD
AIR SPRINGS MUST BE INSTALLED WITH LEVELING VALVES

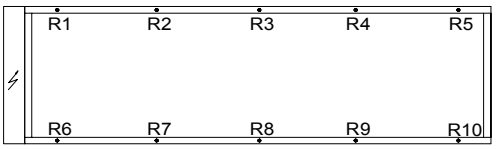
LOAD DISTRIBUTION, kgs. (ALUMINIUM FINS CONDENSER COIL)

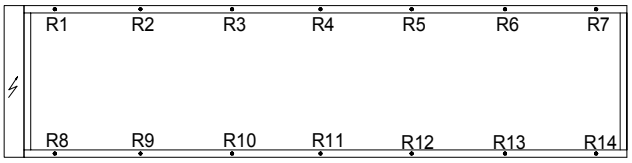
MODEL	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14
ASQ045B	520	504	496	453										
ASQ050B	523	507	499	455										
ASQ055B	650	634	626	524										
ASQ060B	655	639	631	527										
ASQ070B	686	670	662	555										
ASQ080B	594	563	547	493	462	446								
ASQ090B	626	594	578	538	507	491								
ASQ100B	779	748	732	615	584	568								
ASQ115B	877	845	830	722	691	675								
ASQ130B	885	853	837	726	695	679								
ASQ140B	734	707	698	688	640	612	603	594						
ASQ150B	754	726	717	708	657	629	620	611						
ASQ160B	968	934	923	911	799	765	754	742						
ASQ170B	985	951	939	928	813	779	768	756						
ASQ180B	998	963	952	940	823	788	777	765						
ASQ190B	1002	967	956	945	827	793	781	770						
ASQ200B	1003	969	958	946	828	794	782	771						
ASQ220B	1046	1012	995	989	983	862	828	811	805	799				
ASQ230B	1050	1016	998	993	987	864	830	813	807	801				
ASQ240B	1057	1023	1006	1000	994	871	836	819	813	808				
ASQ250B	1075	1040	1023	1017	1012	887	852	835	829	824				
ASQ260B	1114	1080	1063	1057	1051	966	931	914	908	903				
ASQ270B	1119	1084	1067	1062	1056	968	934	916	911	905				
ASQ280B	1123	1089	1071	1066	1060	970	936	918	913	907				
ASQ300B	1064	1046	1037	1027	1018	1014	1009	872	854	845	836	827	822	817
ASQ320B	1077	1058	1049	1040	1031	1026	1022	882	864	854	845	836	831	827
ASQ330B	1078	1060	1051	1041	1032	1028	1023	883	864	855	846	837	832	828
ASQ340B	1082	1063	1054	1045	1036	1031	1027	885	866	857	848	839	834	830
ASQ350B	1125	1105	1095	1085	1075	1070	1065	928	908	898	888	878	873	868
ASQ360B	1129	1109	1099	1089	1079	1074	1069	930	910	900	890	880	875	870
ASQ380B	1134	1114	1104	1094	1084	1079	1074	935	915	905	895	885	880	875
ASQ400B	1137	1117	1107	1097	1087	1082	1077	937	917	907	897	887	882	877
ASQ420B	1167	1147	1137	1127	1117	1112	1107	991	971	961	951	941	936	931
ASQ440B	1172	1152	1142	1132	1122	1117	1112	993	973	963	953	943	938	933





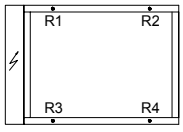


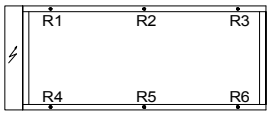


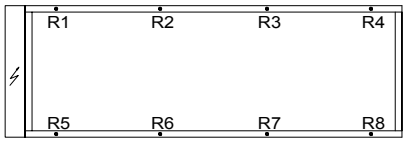


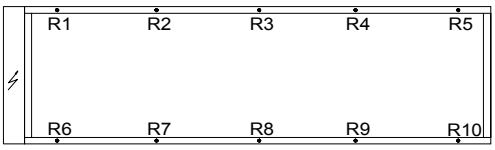
LOAD DISTRIBUTION, kgs. (COPPER FINS CONDENSER COIL)

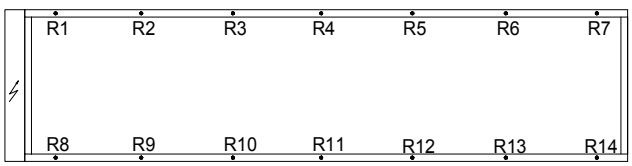
MODEL	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14
ASQ045B	551	535	527	484										
ASQ050B	554	538	531	486										
ASQ055B	698	682	675	572										
ASQ060B	703	687	679	575										
ASQ070B	756	740	732	625										
ASQ080B	631	599	584	530	499	483								
ASQ090B	679	647	632	592	560	545								
ASQ100B	832	801	785	669	637	621								
ASQ115B	951	920	904	796	765	749								
ASQ130B	959	928	912	800	769	753								
ASQ140B	782	755	746	736	688	661	651	642						
ASQ150B	824	796	787	778	727	699	690	681						
ASQ160B	1026	992	980	969	857	823	811	800						
ASQ170B	1060	1026	1014	1003	889	854	843	831						
ASQ180B	1081	1047	1036	1024	906	872	861	849						
ASQ190B	1086	1051	1040	1028	911	877	865	854						
ASQ200B	1087	1053	1041	1030	912	878	866	855						
ASQ220B	1113	1079	1061	1056	1050	929	895	878	872	866				
ASQ230B	1117	1082	1065	1060	1054	931	897	880	874	868				
ASQ240B	1132	1097	1080	1074	1069	945	911	893	888	882				
ASQ250B	1172	1137	1120	1114	1109	984	949	932	926	921				
ASQ260B	1211	1177	1160	1154	1148	1063	1028	1011	1005	1000				
ASQ270B	1216	1181	1164	1159	1153	1065	1031	1013	1008	1002				
ASQ280B	1220	1186	1168	1163	1157	1067	1033	1015	1010	1004				
ASQ300B	1152	1134	1125	1116	1107	1102	1097	961	942	933	924	915	910	906
ASQ320B	1175	1156	1147	1138	1129	1124	1120	980	962	953	943	934	930	925
ASQ330B	1176	1158	1149	1140	1130	1126	1121	981	962	953	944	935	930	926
ASQ340B	1180	1162	1152	1143	1134	1130	1125	983	964	955	946	937	932	928
ASQ350B	1244	1224	1214	1204	1194	1189	1184	1046	1026	1016	1006	996	991	986
ASQ360B	1248	1228	1218	1208	1198	1193	1188	1048	1028	1018	1008	998	993	988
ASQ380B	1252	1232	1222	1212	1202	1197	1192	1054	1034	1024	1014	1004	999	994
ASQ400B	1256	1236	1226	1216	1206	1201	1196	1055	1035	1025	1015	1005	1000	995
ASQ420B	1286	1266	1256	1246	1236	1231	1226	1109	1089	1079	1069	1059	1054	1049
ASQ440B	1291	1271	1261	1251	1241	1236	1231	1112	1092	1082	1072	1062	1057	1052











UNIT INSTALLATION

Based on the specific project requirements, choose the type of vibration isolators best suited for the application. Carefully select the vibration isolators' models / configuration based on the respective point loads and place each mount in its correct position following the foregoing ***Load Distribution Data and Mounting Points Drawing*** provided herewith.

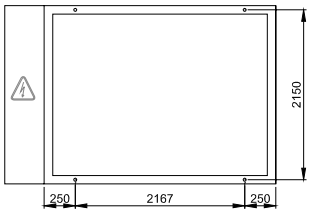
Upon completing the mounting of all vibration isolators in their correct positions, move the unit to its installation location and then lower it carefully in an upright position onto the vibration mounts ensuring that each mount sits in its correct position with respect to the base rail.

For applications with neoprene pad isolators, equipment and isolators do not require bolting to the concrete base or substructure. For applications with spring isolators, follow these guidelines:

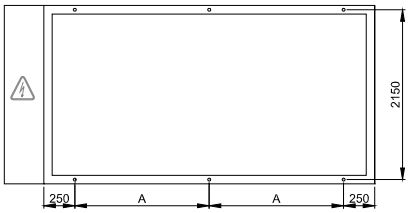
- Ensure that all vibration isolators get engaged in the mounting holes provided in the unit base rail.
- Follow the specific instructions for levelling, adjustment etc. based on the type of spring isolator employed.
- Isolators should be bolted to the concrete base or substructure and the equipment to isolators.

MOUNTING POINTS

ASQ045B-070B

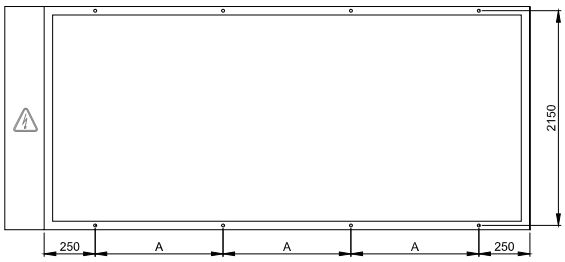


ASQ080B-130B



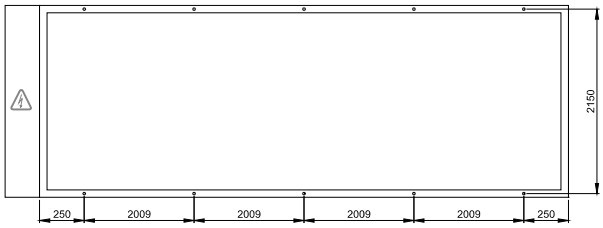
Model	A
ASQ080B	1249
ASQ090B	1249
ASQ100B	1249
ASQ115B	1858
ASQ130B	1858

ASQ140B-200B

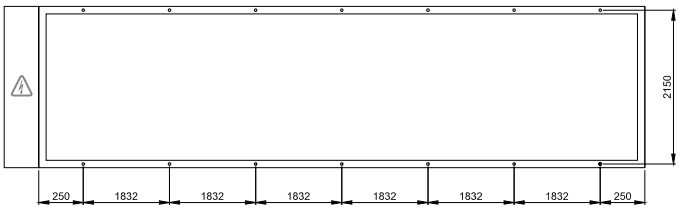


Model	A
ASQ140B	1586
ASQ150B	1586
ASQ160B	2094
ASQ170B	2094
ASQ180B	2094
ASQ190B	2094
ASQ200B	2094

ASQ220B-280B



ASQ300B-440B



NOTE: All dimensions are in millimeters (mm).
TOLERANCE ± 2mm

COOLER PIPING CONNECTIONS

After the unit has been leveled, the external water piping may be made up. The following piping guidelines are served to ensure satisfactory operation of the units. Failure to follow these recommendations may cause damage to the unit or loss of performance and may nullify the warranty.

- Water piping must be connected correctly to the unit i.e., water must enter from the inlet connection on the cooler and leave from the outlet connection.
- A flow switch must be installed in the field piping at the outlet of the cooler (in horizontal piping) and wired back to the unit control panel using shielded cable. There should be a straight run of piping of at least five pipe diameters on either side of the flow switch. Paddle type flow switches can be obtained from ZAMIL which are supplied as optional items.

A flow switch is required to prevent damage to the cooler caused by the unit operating without adequate liquid flow. The flow switch should be connected in the external interlock as shown in the wiring diagram in the control panel. The flow switch MUST NOT be used to start and stop the unit.

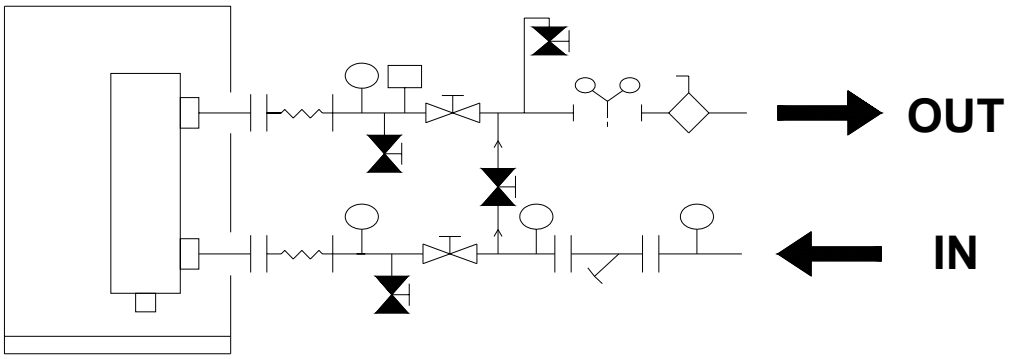
- The chilled water pump(s) installed in the piping system should discharge directly into the unit cooler. The pump(s) may be controlled external to the unit - but an interlock must be wired to the unit control panel (as shown in the wiring diagram) so that the unit can start only upon proof of pump operation.
- Flexible connections suitably selected for the fluid and pressure involved should be provided as mandatory in order to minimize transmission of vibrations to the piping / building as some movement of the unit can be expected during normal operation. The piping and fittings must be separately supported to prevent any loading on the cooler.

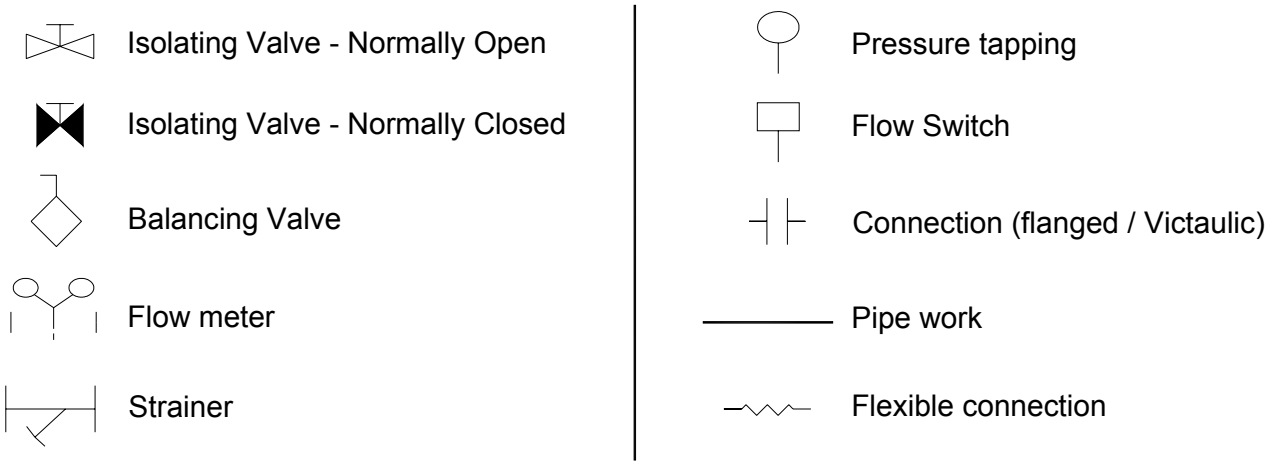
The cooler must be protected by a strainer, preferably of 20 mesh, fitted as close as possible to the liquid inlet connection, and provided with a means of local isolation.

- Thermometer and pressure gauge connections should be provided on the inlet and outlet connections of each cooler. Pressure gauges are recommended to check the water pressure before and after the cooler and to determine if any variations occur in the cooler and system. When installing pressure taps to measure the amount of pressure drop across the water side of the cooler, the taps should be located in the water piping a minimum of 24 inches downstream from any connection (flange etc.) but as near to the cooler as possible.
- Drain and air vent connections should be provided at all low and high points in the piping system to permit complete drainage of the cooler and piping as well as to vent any air in the pipes. Hand shut-off valves are recommended for use in all lines to facilitate servicing.
- The system water piping must be flushed thoroughly before connecting to the unit cooler. The cooler must not be exposed to flushing velocities or debris released during flushing. It is recommended that a suitably sized bypass and valve arrangement is installed to allow flushing of the piping system. The bypass can be used during maintenance to isolate the cooler without disrupting flow to other units.

Any debris left in the water piping between the strainer and cooler could cause serious damage to the tubes in the cooler and must be avoided. The contractor/owner must also ensure that the quality of the water in circulation is satisfactory, without any dissolved gases which can cause oxidation of steel parts within the cooler.

- The following is a suggested piping arrangement at the chiller for single unit installations. For multiple chiller installations, each unit should be piped as shown:

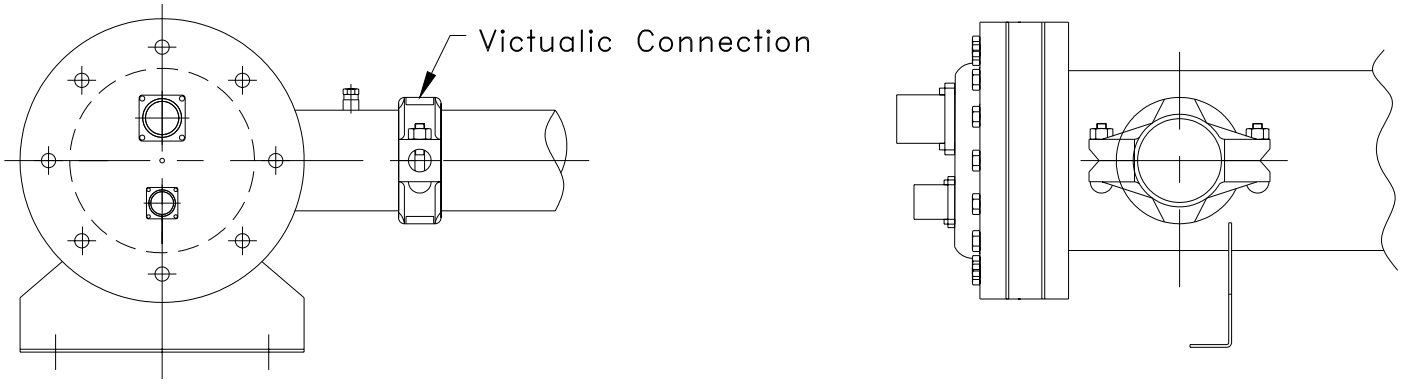




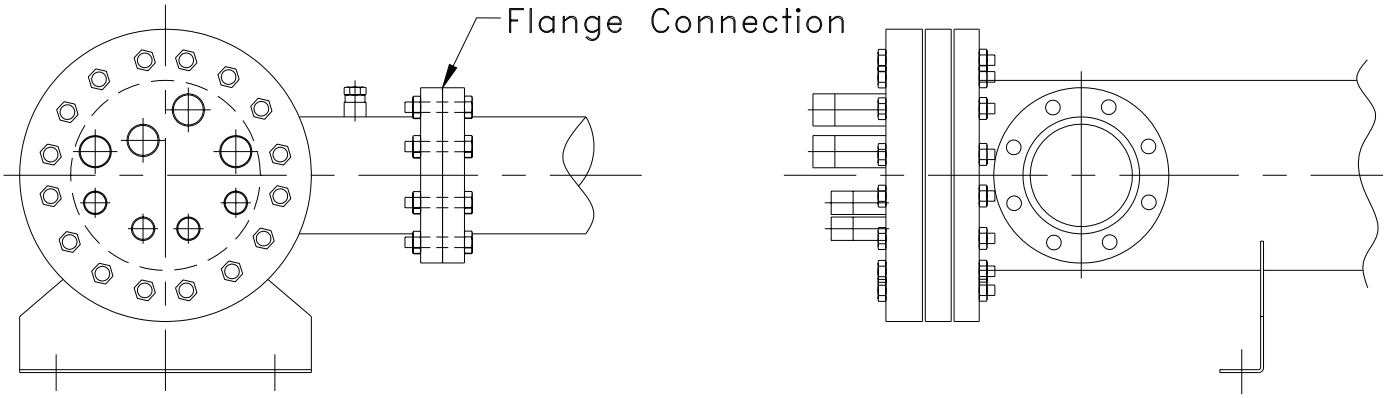
Note: For chillers with two coolers, the connecting pipes for entering and leaving water on one cooler must be joined to the corresponding pipes on the other cooler before connecting to the main headers in the system piping.

COOLER CONNECTION TYPES

Standard chilled liquid connections on all coolers* are of the Victaulic type as shown below:



Flanged Cooler Connections as shown below are available as an option and should be specified with the equipment order:



WATER REQUIREMENTS

Coolers used in these units are made of carbon steel, copper and brass and are suitable for operation with well maintained water systems. Using unclean and untreated water may result in scale and deposit formation causing reduced cooler efficiency or heat transfer and corrosion or pitting leading to possible equipment damage. The more scale forming material and suspended solids in the system water, the greater the chances of scale and deposit formation and fouling. These include calcium, magnesium, biological growth (algae, fungi and bacteria), dirt, silt, clays, organic contaminants (oils), silica, etc. which should be kept to the minimum to retard scale and deposit formation. In order to prevent corrosion and pitting, the pH value of the water flowing through the cooler must be kept between 7 and 8.5.

ZAMIL recommends that a water treatment specialist is consulted to provide and maintain water treatment, this is particularly critical with glycol systems.

Using unclean and untreated water may result in reduced unit performance and equipment damage.

ELECTRICAL CONNECTIONS, POWER AND CONTROL WIRING

All units are wired completely at the factory prior to delivery. The connections that must be made by the installer are to the main power source and interlocking with water flow switch, pumps, remote monitoring system and two barrel units water temperature sensor, if any.

In connecting power wiring to the unit, the following guidelines must be followed to ensure safe and satisfactory operation of the units. Failure to follow these recommendations could cause harm to personnel or damage to the unit and may nullify the warranty:

- All field wiring should be carried out in accordance with the National Electrical Code (NEC) and local codes.
- All wiring is to be checked for damages and all terminal connections for tightness. All wiring to the unit should use copper conductors only, sized based on the minimum circuit ampacity (MCA) values given in the Electrical Data Section of this manual or the unit nameplate.
- The power supply should match the unit nameplate in volts, phase and Hertz. The voltage imbalance between phases must not exceed 2%.

Main power must be supplied from a single field supplied and mounted Disconnect switch, using dual element time delay fuse or circuit breaker.

If the supply voltage phase imbalance is more than 2%, contact your local electric utility company immediately.

No additional controls (relays, etc.) should be mounted in the unit control panel unless recommended by Zamil. Power and control wiring not connected to the unit should not be run through the unit control panel. If these precautions are not observed it could lead to a risk of electrocution or nuisance faults.

After connection of wiring, do not switch ON main power to the unit out rightly. Some internal components get live when the main disconnect is switched ON and this must be done by authorized personnel only.

If the unit is mounted on spring vibration isolators, electrical service to the unit must also be flexibly connected (by means of a suitable flexible conduit), as some movement of the unit can be expected during normal operation.

In regards to the controls and their wiring, please ensure compliance to the following points to avoid Electro Magnetic Interference and to optimise the efficiency of EMI filters:

- Make sure that the conducting area around board support holes on main, auxiliary and user boards are very well grounded to the mounting plates through conducting studs, screws and metal spacers.
- Cables for transducers, sensors, user boards and serial lines must be wired far from high voltage lines like main power and controls power.
- For shielded cables, connect the shield wire to the ground; exposed wire length must be 15 mm maximum.

Control wiring/cables connected to the control panel should never be run in the same conduit with power wiring.

Some very important recommendations with regard to the main power switching On & Off to these chillers is as follows. Failure to follow these recommendations could result in serious damage to the equipment:

Removing high voltage power (switching OFF the main disconnect) will disable the 230VAC supply voltage to controls and the compressor crankcase heaters. At initial start-up or after a prolonged power disconnection, the crankcase heaters must be energized for a minimum of 12 hours (main disconnect should be switched ON) before starting/operating the unit.

If the unit is located in an area where low ambient temperatures are encountered, do not disconnect main power unless alternate means are provided to assure operation of the cooler heater or the liquid system has been drained completely.

After a prolonged power disconnections do not switch ON main power to the unit unless power supply cables and unit control panel have been properly inspected.

ELECTRICAL DATA

UNIT SIZE	Supply Voltage					COMPRESSOR TYPE1						COMPRESSOR TYPE2						CONDENSER FAN					CRANKCASE HEATER			COMP. WINDING
	Nominal (V-Ph-Hz)	MIN	MAX	MCA	MOCP	QTY.	RLA (each)	LRA (each)	CB Poles	CB MTA	CB QTY.	QTY.	RLA (each)	LRA (each)	CB Poles	CB MTA	CB QTY.	QTY.	FLA (each)	TOTAL KW	FCA	CB QTY	Volts	Total Watts	Total Amps	
ASQ045B	380/415-3-50	342	456	115	198	1	82.4	423	3	66	2	-	-	-	-	-	-	4	3.12	4.40	12.48	2	230	200	0.87	PW
ASQ050B	380/415-3-50	342	456	123	212	1	88.8	423	3	71	2	-	-	-	-	-	-	4	3.12	4.40	12.48	2	230	200	0.87	PW
ASQ055B	380/415-3-50	342	456	142	245	1	103.5	520	3	83	2	-	-	-	-	-	-	4	3.12	4.40	12.48	2	230	300	1.30	PW
ASQ060B	380/415-3-50	342	456	161	281	1	119.2	612	3	95	2	-	-	-	-	-	-	4	3.12	4.40	12.48	2	230	300	1.30	PW
ASQ070B	380/415-3-50	342	456	184	322	1	137.8	665	3	110	2	-	-	-	-	-	-	4	3.00	5.40	12	2	230	300	1.30	PW
ASQ080B	380/415-3-50	342	456	203	286	2	82.4	423	3	66	4	-	-	-	-	-	-	6	3.00	8.10	18	3	230	400	1.74	PW
ASQ090B	380/415-3-50	342	456	218	307	2	88.8	423	3	71	4	-	-	-	-	-	-	6	3.00	8.10	18	3	230	400	1.74	PW
ASQ100B	380/415-3-50	342	456	251	354	2	103.5	520	3	83	4	-	-	-	-	-	-	6	3.00	8.10	18	3	230	600	2.61	PW
ASQ115B	380/415-3-50	342	456	292	411	2	119.2	612	3	95	4	-	-	-	-	-	-	8	3.00	10.80	24	4	230	600	2.61	PW
ASQ130B	380/415-3-50	342	456	334	472	2	137.8	665	3	110	4	-	-	-	-	-	-	8	3.00	10.80	24	4	230	600	2.61	PW
ASQ140B	380/415-3-50	342	456	340	478	2	137.8	665	3	110	4	-	-	-	-	-	-	10	3.00	13.50	30	5	230	600	2.61	PW
ASQ150B	380/415-3-50	342	456	364	512	2	148.3	665	3	119	4	-	-	-	-	-	-	10	3.00	13.50	30	5	230	600	2.61	PW
ASQ160B	380/415-3-50	342	456	372	476	3	103.5	520	3	83	6	-	-	-	-	-	-	12	3.00	16.20	36	6	230	900	3.91	PW
ASQ170B	380/415-3-50	342	456	406	524	2	118.3	520	3	95	4	1	103.5	520	3	83	2	12	3.00	16.20	36	6	230	900	3.91	PW
ASQ180B	380/415-3-50	342	456	454	587	2	132.8	612	3	106	4	1	119.2	612	3	95	2	12	3.00	16.20	36	6	230	900	3.91	PW
ASQ190B	380/415-3-50	342	456	468	600	3	132.8	612	3	106	6	-	-	-	-	-	-	12	3.00	16.20	36	6	230	900	3.91	PW
ASQ200B	380/415-3-50	342	456	484	622	3	137.8	665	3	110	6	-	-	-	-	-	-	12	3.00	16.20	36	6	230	900	3.91	PW
ASQ220B	380/415-3-50	342	456	523	642	2	119.2	612	3	95	4	2	103.5	520	3	83	4	16	3.00	21.60	48	8	230	1,200	5.22	PW
ASQ230B	380/415-3-50	342	456	555	674	4	119.2	612	3	95	8	-	-	-	-	-	-	16	3.00	21.60	48	8	230	1,200	5.22	PW
ASQ240B	380/415-3-50	342	456	578	716	1	137.8	665	3	110	2	3	119.2	612	3	95	6	16	3.00	21.60	48	8	230	1,200	5.22	PW
ASQ250B	380/415-3-50	342	456	596	734	2	137.8	665	3	110	4	2	119.2	612	3	95	4	16	3.00	21.60	48	8	230	1,200	5.22	PW
ASQ260B	380/415-3-50	342	456	596	734	2	137.8	665	3	110	4	2	119.2	612	3	95	4	16	3.00	21.60	48	8	230	1,200	5.22	PW
ASQ270B	380/415-3-50	342	456	634	771	4	137.8	665	3	110	8	-	-	-	-	-	-	16	3.00	21.60	48	8	230	1,200	5.22	PW
ASQ280B	380/415-3-50	342	456	657	806	2	148.3	665	3	119	4	2	137.8	665	3	110	4	16	3.00	21.60	48	8	230	1,200	5.22	PW
ASQ300B	380/415-3-50	342	456	671	775	4	103.5	520	3	83	8	2	88.8	423	3	71	4	18	3.00	24.30	54	9	230	1,600	6.96	PW
ASQ320B	380/415-3-50	342	456	734	852	2	118.3	520	3	95	4	4	103.5	520	3	83	8	18	3.00	24.30	54	9	230	1,800	7.83	PW
ASQ330B	380/415-3-50	342	456	749	867	3	118.3	520	3	95	6	3	103.5	520	3	83	6	18	3.00	24.30	54	9	230	1,800	7.83	PW
ASQ340B	380/415-3-50	342	456	799	918	6	119.2	612	3	95	12	-	-	-	-	-	-	18	3.00	24.30	54	9	230	1,800	7.83	PW
ASQ350B	380/415-3-50	342	456	811	930	6	119.2	612	3	95	12	-	-	-	-	-	-	22	3.00	29.70	66	11	230	1,800	7.83	PW
ASQ360B	380/415-3-50	342	456	855	988	3	132.8	612	3	106	6	3	119.2	612	3	95	6	22	3.00	29.70	66	11	230	1,800	7.83	PW
ASQ380B	380/415-3-50	342	456	890	1028	4	137.8	665	3	110	8	2	119.2	612	3	95	4	22	3.00	29.70	66	11	230	1,800	7.83	PW
ASQ400B	380/415-3-50	342	456	927	1065	6	137.8	665	3	110	12	-	-	-	-	-	-	22	3.00	29.70	66	11	230	1,800	7.83	PW
ASQ420B	380/415-3-50	342	456	961	1110	3	148.3	665	3	119	6	3	137.8	665	3	110	6	22	3.00	29.70	66	11	230	1,800	7.83	PW
ASQ440B	380/415-3-50	342	456	993	1141	6	148.3	665	3	119	12	-	-	-	-	-	-	22	3.00	29.70	66	11	230	1,800	7.83	PW

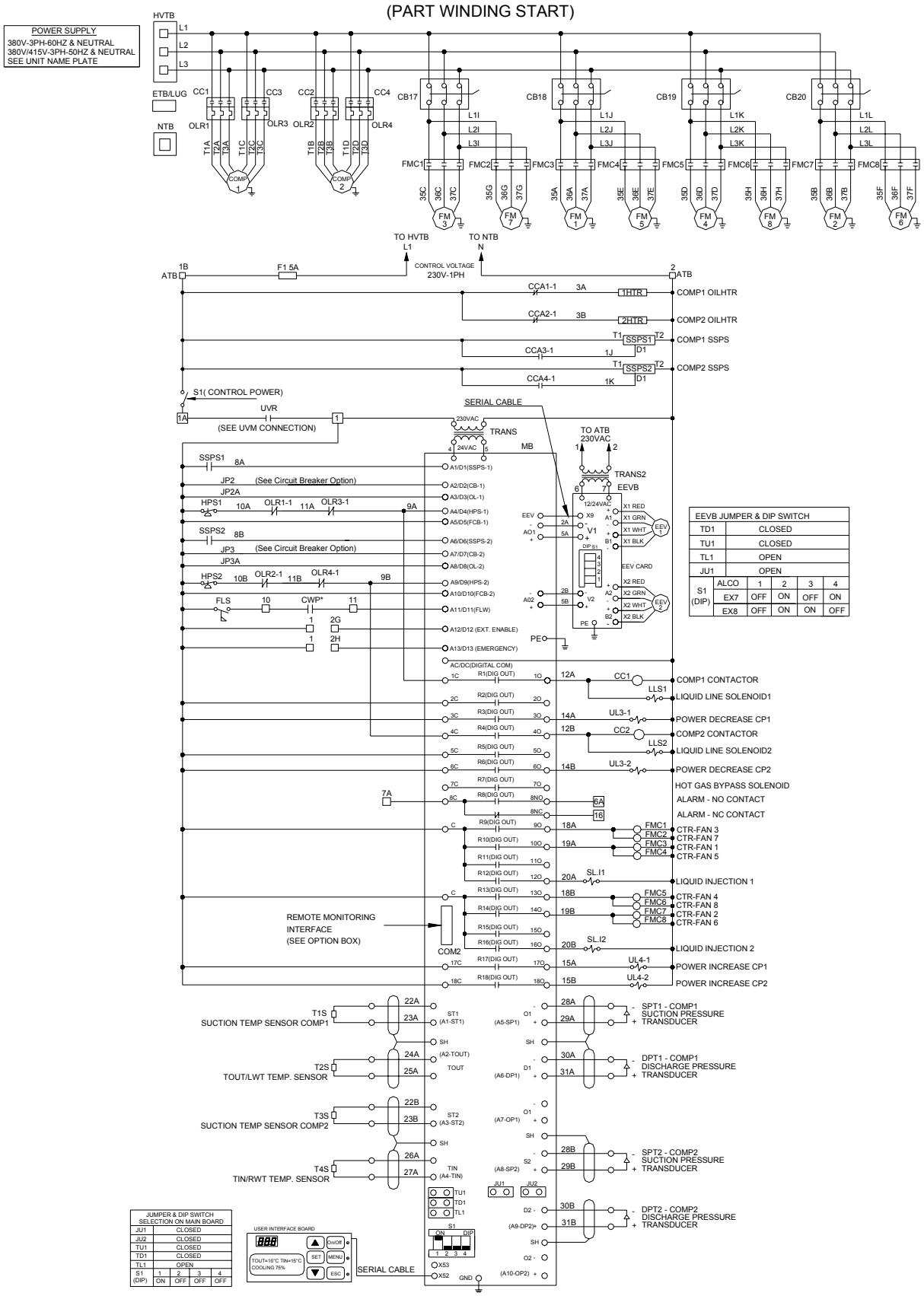
LEGENDS:

MCA	-Minimum Circuit Ampacity per NEC 430-24
MOCP	-Maximum Over Current Protection
RLA	-Rated Load Amps
LRA	-Locked Rotor Amps
CB	-Circuit Breaker
FCA	-Fan Circuit Amps
MTA	-Must Trip Amps
MOC	-Max. operating current
HP	-Horse Power
PH	-Phase
PW	-Part Winding Start Compressor

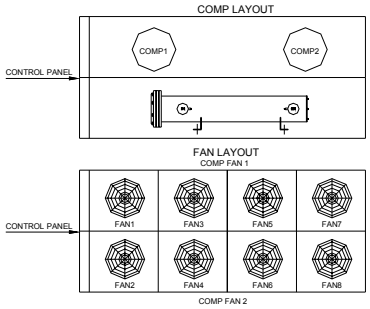
NOTES:

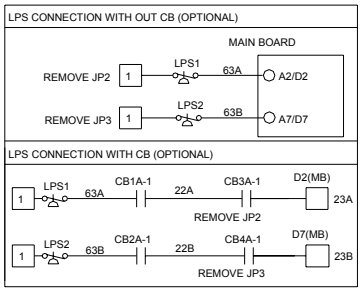
1. Main power must be supplied from a single field supplied and mounted fused disconnections using dual element time delay fuse or circuit breaker.
2. The maximum incoming wire size is 500MCM. On units having MCA greater than 500MCM wire, the factory supplied terminal block will accept two or more parallel field wires per pole phase
3. The compressor crankcase heaters must be energized for 12 hours before the unit is initally started or after a prolonged power disconnection.
4. All Field Wiring must be in accordance with NEC and local standards.
5. Minimum and Maximum unit supply voltage are shown in the tabulated data above.
6. Neutral line is required on 380/415V-3Ph-50Hz (4 wires) power supply.
7. The + / - 10 % voltage variation from the nominal is accepted for short time and not permanent.
8. Customer to specify the exact nominal power supply available at the site so that electrical components are selected accurately, failing to do so will affect unit performance & terms of warranty
9. Under compressor type 1 are the big compressor or compressor with economizer and under type 2 are the small compressor or compressor without economizer.

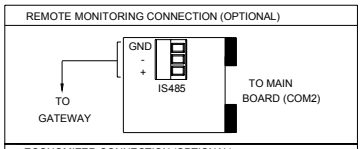
TYPICAL SCHEMATIC WIRING DIAGRAM

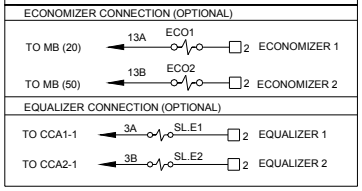


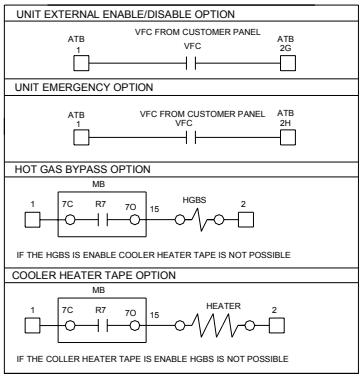
TYPICAL SCHEMATIC WIRING DIAGRAM

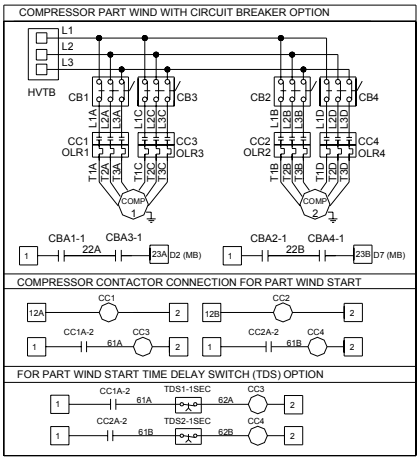


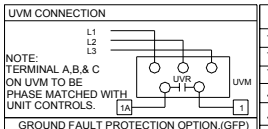




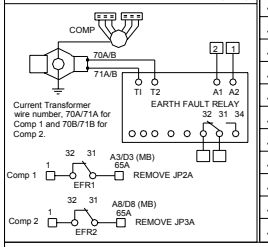


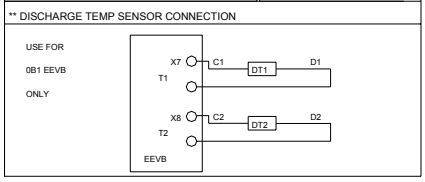






JUMPER SETUP ON MAIN BOARD	
TL2	OPEN
TD2	CLOSED
TU2	CLOSED
JU11	1-2 CLOSED
JU13	1-2 CLOSED
JU15	1-2 CLOSED
JU5	1-2 CLOSED
JU6	1-2 CLOSED
JU7	1-2 CLOSED
JU8	1-2 CLOSED
JU9	1-2 CLOSED
JU4	1-2 CLOSED
JU3	1-2 CLOSED
JU19	1-2 CLOSED
JU12	1-2 CLOSED
JU10	1-2 CLOSED





LEGEND	
CBA	THERMAL MAGNETIC CIRCUIT BREAKER AUXILIARY
CC	COMPRESSOR CONTACTOR
CCA	COMP.CONTACTOR AUXILIARY
COMP	COMPRESSOR
CWP	CHILLED WATER PUMP
DT	DISCHARGE TEMPERATURE SENSOR
ETB	EARTH TERMINAL BLOCK
FLS	FLOW SWITCH
FM	FAN MOTOR
FMC	FAN MOTOR CONTACTOR
FT	THERMAL MAGNETIC CB FAULT TRIP CONTACTS
F	FUSE
HPS	HIGH PRESSURE SWITCH
HVTB	HIGH VOLTAGE TERMINAL BLOCK
HGBS	HOT GAS BYPASS SOLENOID
OLR	OVERLOAD RELAY
JP	JUMPER
NTB	NEUTRAL TERMINAL BLOCK
PT	PRESSURE TRANSDUCER
P	PROPORTIONAL BAND
S1	CONTROL SWITCH
SSPS	SOLID STATE PROTECTION SYSTEM
TRANS	TRANSFORMER
TDS	TIME DELAY SWITCH
TS	TEMPERATURE SENSOR
UVM	UNDER VOLTAGE MONITOR
UVR	UNDER VOLTAGE RELAY
LPS	LOW PRESSURE SWITCH
MB	MASTER/ MAIN/ MOTHER BOARD
SB	SLAVE/ AUXILLIARY BOARD
SLE	ECONOMIZER SOLENOID
UL	UNLOADER
——	FIELD WIRING
☐	TERMINAL BLOCK OR TERMINATION POINT
*	FIELD SUPPLY

LEGENDS ON MAIN BOARD	
A../D..	DIGITAL INPUT1
C/1C..	COMMON
1O...	DIGITAL OUT 1
DC	DIGITAL COMMON
T1	THERMISTOR 1
SH	SHIELD
X52/X53	SERIAL COMMUNICATION PORT
PE	POTENTIAL EARTH
JU/TU/TL/TD	BOARD JUMPERS

NOTES
1. FUSES TO BE DUAL ELEMENT TYPE.
2. ALL FIELD WIRING TO COMPLY WITH LOCAL CODES.
3. USE COPPER CONDUCTORS ONLY.
4. DISCONNECT MEANS AND BRANCH CIRCUIT PROTECTION SHALL BE PROVIDED BY INSTALLER
5. IF POWER SUPPLY HAS BEEN INTERRUPTED FOR A LONG PERIOD, CRANKCASE HEATERS MUST BE ENERGIZED FOR 12 HRS. MINIMUM, BEFORE STARTING THE COMP.
6. NEUTRAL LINE REQUIRED ON 380V-3Ph-60Hz POWER SUPPLY ONLY.

INSTALLATION INSPECTION

It is the responsibility of contractor or owner to verify and ensure that the following essential requirements are complied:

- Unit installed on flat concrete base and meets the specified clearances.
- Vibration isolators are installed properly.
- Ensure that all valves including balancing valves, globe valves, stop valves, motorized valves, drain & air vent connections and flow meters are installed as per the requirement.
- Temperature and pressure gauges provided at inlet and outlet piping of the cooler.
- Ensure that all temperature and pressures gauges provided on the system are duly calibrated.
- Strainer is installed on chilled water inlet to the unit.
- Water flow switch is provided and at its correct location.
- Field wiring is complete and all sensors and switches interlocked with the controller.
- All optional sensors, gauges, valves etc. if any are installed and connected to the controller.
- Ensure that chilled water pump is interlocked with the controller.
- Chilled water pumps are suitable to handle the required flow rate, head etc.
- All wiring connections are tight.
- Unit control panels have the proper schematic diagrams.
- Ensure compressor-mounting retainer brackets are removed and adjust the bolts.
- Ensure that all condenser fans motor propellers are tightened.
- Flexible connections provided at interconnection with chilled water piping and power cable entry.
- Chilled water lines to the cooler are insulated.
- Check for proper grounding of the chiller.

START-UP, COMMISSIONING & OPERATING PROCEDURES

GENERAL

The Start-up and Commissioning of units must be carried out by suitably trained and qualified personnel only preferably *by Zamil* in accordance with the following instructions. Upon completion of Start-up and Commissioning, duly filled up and certified check out forms for each unit (sample check out form given in appendix of this manual) must be forwarded to Zamil Head Office - Dammam in order to avail the warranty.

Do not start the unit before completing start-up and commissioning service.

REQUEST FOR START-UP REPRESENTATIVE

Start-up service is provided by Zamil as optional and should be requested when the units are ordered. When rendering the start-up service, a representative will be sent to the site upon proper completion of installation.
The contractor/owner should have competent service and operating personnel in attendance to assist in the work involved and also to be trained in the operation and maintenance of these units.

The representative shall perform the following duties:

- Inspection of installation to verify compliance to all essential requirements.
- Perform the Start-up & Commissioning of units and ensure they are operating satisfactorily.
- Instruct the concerned personnel for the specified length of time as agreed in the contract on proper operation and maintenance of these units.

Compressor crankcase heaters should be energized a minimum of 12 hours prior to Start-up. This will ensure that the compressor lubricating oil is warm enough to vaporize any dissolved refrigerant and that the oil is within the normal operating temperature range.

PRE-STARTUP REQUISITES

The unit is ready for start-up when the following procedures have been completed:

- Installation is complete and has been thoroughly inspected / verified as instructed earlier in this manual.
- Ensure that all piping has been completed and tested. Water piping and cooler are filled with clean treated water. If ambient temperatures are expected to fall below liquid freezing point (0^{o}C for pure water) add pre-determined amount of non-corrosive anti-freeze (Ethylene glycol) to prevent freeze-up.
- Unit has been leak tested, leaks corrected and charging completed.
- Electrical connections are made and properly fused.
- Compressor crankcase heaters have been energized for a minimum of 12 hours.
- Check all refrigerant valves to be sure they are open.

- Turn on the chilled water pump, check direction of rotation and adjust the water flow through the cooler to the specified flow rate. Bleed off all entrained air.
- Calibrated pressure gauges have been connected to the suction, discharge and oil pressure ports.
- Manually energize the condenser fan starters and check the fan rotation which can be changed on 3-phase motors by interchanging any two wires on the main terminal block.
- Check the power supply voltage. Do not operate the unit if voltage deviation is not within acceptable range (acceptable voltage range is ± 10% of the rated nominal voltage - temporarily).

Do not utilize generator power for Start-up & Commissioning or Operating these units, it could be detrimental for this equipment. Consult Zamil for further information and guidance in this regard.

START-UP OF THE SYSTEM

During Start-up and Commissioning, there should be sufficient heat load to run the unit under stable full load operation to enable the unit controls, and system operation to be set up correctly and a commissioning log taken. Ensure that the Microprocessor Controller is properly programmed - refer to the relevant section in this manual.

Make use of the Start-up and Commissioning checklist provided in the Appendix section of this manual for step by step guidelines to accomplish this task.

Controller Setpoints:

Adjust the controller custom set points as necessary following the instructions given in Microprocessor Controller section of this manual and ensuring compliance with the requirements. If you are not sure of the appropriate set points, do not try to change/modify the current set point and contact ZAMIL for guidance.

Start-up:

- Start the unit by pushing **ON/OFF** key in the controller. The ON LED is lit.
- After 15 seconds delay, the unit is operational.
- At first call for cooling, the controller will de-energize the crankcase heater and start one condenser fan.
- After 20 seconds from condenser fan operation, the lead compressor and liquid solenoid valve are operated.
- Allow the unit to stabilize and confirm proper operation before moving to SYSTEM CHECKOUT.
- To halt the unit, press again **ON/OFF** key and the ON LED is off.

Notes:
Rate of compressor staging and bringing on more compressors depends on load requirement sensed via Leaving Water Temperature (LWT).

System Checkout:

- Check all operating pressures & temperatures and subcooling & superheat.
- Check liquid line sight glass. The refrigerant shall be bubbles-free clear liquid. Existence of bubbles indicates under charged circuit.
- Check the compressor crankcase sight glass for oil level. It should be at or slightly above the center of this sight glass while the compressor is in operation. If not, see below mentioned instructions on "Lubrication".
- Safety controls are factory set and must be maintained at settings indicated on the wiring diagram.
- Check the water temperatures (both in and out) and water flow rate to ensure that unit is operating within the specified limits. See below mentioned instructions on "System Water Flow Rate and Pressure Drop" for further information.
- Check compressor spring suspension for any unacceptable waving.
- Follow the guidelines given in Start-up & Commissioning checklist provided in this manual to complete this work.

External Enabling:

To make the unit start and stop from a remote switch an EXEN (External Enabling) input is supplied:

- Unit must be set the first time in on status through the ON/OFF key (the green led should therefore be ON).
- The auto-restart mode should be selected in set-up (**P22 =** 1) to allow the system to remember its status even after a loss of power supply.
- If the EXEN input is energised the machine is stopped (using the pump down procedures but without enabling the multiple pump downs) and the display shows "LOCK: REMOTE OFF".
- If the input is not energised the units run normally starting with the normal staging.

In OFF status - the green LED off.
If the EXEN input is energised the display shows "LOCK: REMOTE OFF".
If the EXEN input is not energised the display shows regularly "SYSTEM OFF".
To toggle the unit status from off to on and from on to off the ON/OFF key should be normally used.

LUBRICATION

A properly operated unit should run with the compressor crankcase bottom warm to touch. Check oil level frequently to see that a sufficient amount of oil remains in the crankcase. Compressor oil level can be checked by sight glass. To make sure that proper oil level is observed, operate the compressor and oil level should appear within the sight glass range. For further information on oil adding/charging, oil contamination etc., refer to the Maintenance Manual.

SYSTEM WATER FLOW RATE AND PRESSURE DROP

The quantity of chilled water being circulated can be estimated by determining the water pressure drop through the cooler and reading GPM from the appropriate pressure drop curve. An alternate method of determined GPM is to measure pressure difference from pump inlet to outlet and read GPM from pump curve.

During unit operation, water flow rate must not vary more than ± 5% from the design flow rate. The water flow switch should be calibrated accordingly. The maximum and minimum water flow rates for all unit models and the pressure drop chart are given below. The design and operating flow rates must be within this range.

Model ASQ-B	CURVE NO.	MINIMUM GPM	Maximum GPM
045	1	73	122
050	1	82	125
055	1	87	149
060	1	92	163
070	1	111	189
080	1	125	219
090	2	165	242
100	2	165	273
115	3	197	322
130	3	227	353
140	4	239	382
150	4	279	397
160	5	267	435
170	5	305	456
180	5	321	494
190	6	338	516
200	6	336	544
220	3	377	615
230	3	388	638
240	3	406	657
250	3	430	680
260	4	439	722
270	4	470	757
280	4	504	768
300	5	526	833
320	5	567	887
330	5	584	895
340	5	566	943
350	5	594	972
360	5	640	992
380	6	657	1070
400	6	686	1104
420	7	773	1167
440	7	827	1184

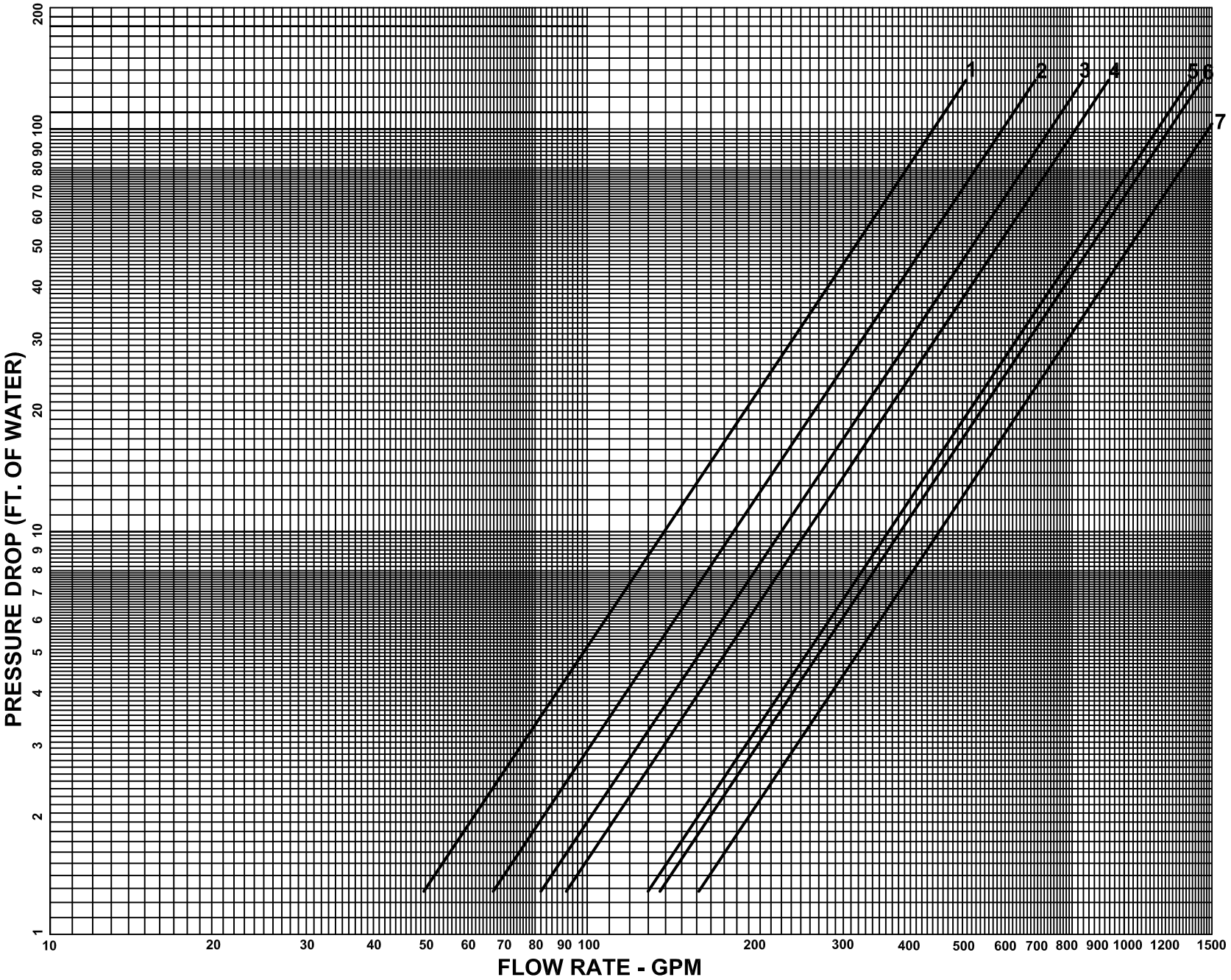
CONVERSION FACTOR : GPM = 0.063 L/S
: ftH2O=2.989 kPA

The above water flow rate limits must not be exceeded at any time. Operation outside this range might result in cooler failure. Special care should be taken when multiple chillers are fed by a single pump.

When using glycol solution, flow rate and pressure drop are higher than with water. Special care must be taken not to exceed the limits. Consult Zamil for further information and guidance in this regard.

Zamil
Air Conditioners

COOLER WATER PRESSURE DROP-ASQ-B



NORMAL OPERATION AND CYCLING

Once the unit has been started, all operations are fully automatic. After an initial period at minimum capacity on the lead compressor, the control system will adjust the unit load depending on the chilled liquid temperature and rate of temperature change. If high heat load is present, the controller will increase the capacity of the lead compressor and/or start-up the other compressor. If very little heat load is present, the lead compressor will continue at minimum capacity or may simply stop again to avoid overcooling the liquid. If the latter is the case, one compressor will restart automatically should the liquid temperature rise again. Once a compressor is running, discharge pressure rises as refrigerant is pumped into the air cooled condenser coils. This pressure is controlled by stages of fans to ensure maximum unit efficiency while maintaining sufficient pressure for correct operation of the condensers and expansion valves. When a compressor is running the controller monitors oil pressure, motor current, and various other system parameters such as discharge pressure, chilled liquid temperature, etc. Should any problems occur; the control system will immediately take appropriate action and display the nature of the fault (Refer Microprocessor Controller Section for details).

COMPRESSOR STAGING AND SEQUENCE OF OPERATION

Sequence of Operation:

The following describes the sequence of operation for a two-screw compressor chiller unit.
Operation is similar for a one or four compressor unit.
For initial start-up, the following conditions must be met:

- All power supplied to the unit shall be energized for 12 hours.
- Control power switch on for at least 5 minutes.
- All safety conditions satisfied.
- Press ESC on the microcomputer keypad.
- Chilled water pump running and chilled water flow switch contact closed.
- Customer interlock contact closed, if any.

STAGE ON SEQUENCE:

Staging ON & OFF sequence shall be accomplished by the Leaving water temperature control selection.

Stage # 1:
If the Leaving water temperature is greater than the Stage 1-ON water temperature set point value, the compressor #1 liquid line solenoid & slider control valves shall be switched ON. Now the compressor is in the minimum or unloaded capacity. The compressor capacity is varied to achieve the full/part load capacity as per the load demand.

As the discharge pressure of Compressor # 1 rises, the corresponding fans are energize accordingly to the fan stage-ON set point. If the discharge pressure falls below the fan stage- OFF set point value, the corresponding fans will turn off.

Stage # 2:
If the Leaving Water Temperature is greater than the Stage 2- ON water temperature set point value, the Compressor # 2 liquid line solenoid & slider control valves shall be switched ON. Now the compressor is in the minimum or unloaded capacity. The compressor capacity is varied to achieve the full/ part load capacity as per the load demand.

As the discharge pressure of Compressor # 2 rises, the corresponding fans are energize accordingly to the fan stage-ON set point. If the discharge pressure falls below the fan stage-OFF set point value, the corresponding fans will turn off.

STAGE – OFF SEQUENCE

During the staging OFF, the first-in last-out sequence is adopted, if equalization of compressor timing is not selected. Else the more used is switched off.

As the applied load decreases and when the leaving water temperature falls below the stage 2-OFF water temperature set point value, stage 2 is turned off.

If the leaving water temperature falls below the stage 1-OFF water temperature set point value, the stage 1 is turned off.

CAPACITY CONTROL STEPS

Capacity control is achieved by cycling compressor ON/OFF and slider capacity control valve. On multiple compressor units, capacity is controlled by a combination of slider capacity control valve and compressor staging.

These chillers are equipped with **stepless capacity control system** on compressors as a standard feature for very accurate response to load requirements and best part load efficiency. Each compressor is equipped with a slider controller that enables to modulate capacity between 25% to 100%, thus giving a broad range to control total chiller capacity between 10% to 100% on an average. This system has tremendous advantages such as infinite capacity modulation allowing the compressor capacity to exactly match the cooling load, reduced compressor cycling which leads to better operationally reliability and reduced operating costs.

Optionally these chillers can be provided with 4-step capacity control on compressors for stepped load shedding as required by most energy management systems and suited to systems with high inertia. In this case, the capacity control steps are as follows:

MODEL NUMBER	% FULL LOAD	
	STEP CAPACITY CONTROL (option-I)	STEP CAPACITY CONTROL WITH HGBP (option-II)
ASQ045B-ASQ070B	100-50-OFF	100-50-HGPB-OFF
ASQ080B-ASQ150B	100-75-63-50-25-OFF	100-75-63-50-25-HGBP-OFF
ASQ160B-ASQ200B	100-83-66-50-33-16-OFF	100-83-66-50-33-16-HGBP-OFF
ASQ220B-ASQ280B	100-87-75-63-50-37-25-12-OFF	100-87-75-63-50-37-25-12-HGBP-OFF
ASQ300B-ASQ440B	100-92-83-75-66-58-50-42-33-25-16-8-OFF	100-92-83-75-66-58-50-42-33-25-16-8-HGBP-OFF

NOTES:

1. All models have slider capacity control valve on all compressors.
2. HGBP = Hot gas bypass available on lead compressor for all models (option).
3. HGBP modulates to approximately 80% of its compressor lowest unloaded capacity.

UNIT SHUTDOWN

The unit can be stopped at any time by switching the unit ON/OFF key on the keypad and the ON LED is off.
The compressor oil heaters will energize to prevent refrigerant condensing in the compressor crankcase and to prevent the compressor oil becoming saturated with refrigerant. If ambient temperatures are low, the cooler heater (if provided) will also energize to prevent the possibility of liquid freezing in the vessels. The mains power to the unit should normally be NOT switched OFF, even when the unit is not required to run. If main power must be switched OFF, (for extended maintenance or a shutdown period), the compressor suction, discharge and other service valves should be closed and if there is a possibility of liquid freezing due to low ambient temperatures, the cooler should be drained. The closed valves should be opened and power must be switched on for at least 24 hours before the unit is restarted.

MICROPROCESSOR CONTROL SYSTEM

INTRODUCTION

This section is to describe the chiller control system. The hardware will have the following characteristics:

- Components UL approved.
- The components legends, polarity and pin #1 of IC are identifiable on silk screen on PCB.
- QC check will be marked on each tested PCB.
- For EMI interference the controller is compliant to EN 61000-4-4 class 4 for I/O and power supply, EN 55011 for conducted emission on power supply cable limit class B, EN 61000-3-2 with limit class A for harmonic current distortion, EN 61000-3-3 for supply fluctuation and flickers.
- Built using SMD (Surface Mount Device) technology.
- 16-bit Mitsubishi microprocessor with a 128Kb (or 256Kb TBD) "flashes" EPROM memory.
- Flash memory can be programmed "on board", through PC or Hardware Key; i.e. there's no need to replace the component it to upgrade the software.
- Real Time Clock on board

The system architecture is as follows:

- User interface "CO1" with LCD display.
- One master controller board with an user interface "CO1" for the first 2 compressors connected via serial bus (RS485);
- One compressor board (slave) for each additional circuit/compressor pair, serially (RS485 same as master – user connection) connected to the others;

The board's technical specs are the following:

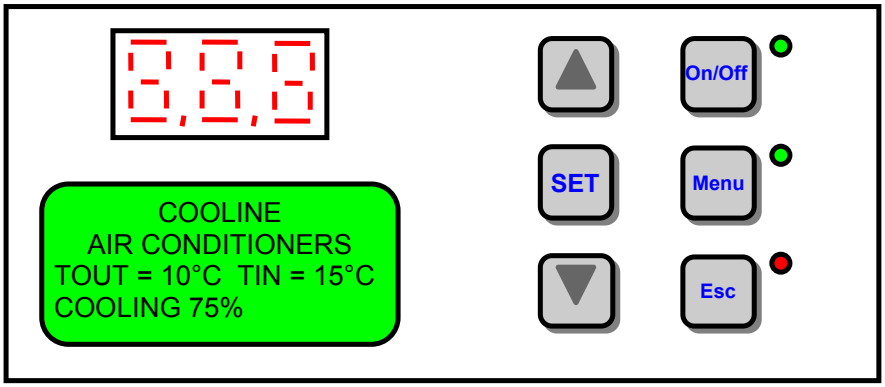
Master board and slave compressors board:

- Dimensions mm. 291 x 137 mm
- Power supply: 24 Vac ±10% 50/60Hz, 20 VA protected by 5x20mm fuse 1.6AT.
- Temperature range 0÷70°C.
- 10 bit A/D converter on-board.
- 18 DIG-OUT relays.
- 4 ANALOG-OUT.
- 20 DIG-IN alarms 115 VAC.
- 12 ANALOG-IN
- Serial interface for User board / Slave board connection (485)
- Serial interface option for Remote Monitoring System / micro programming (With 485 / 232 adapter)
- Serial interface for EEV board connection (485)
- Serial interface for Power line analyser (485)
- Serial interface for Hardware Key (SPI)

User Interface board description:

- Dimensions mm. 220 x 111mm
- Temperature range 0÷70°C (extended temperature range LCD).
- 3 digits LED 7 segments display for temperature.
- 20x4 characters LCD back illuminated display for status and alarms.
- On-board 6 buttons keyboard:
  1. SET to enter in set mode and change the set point
  2. UP to scroll up or increase values
  3. DOWN to scroll down or decrease values
  4. ESC alarm reset or menu quit key
  5. ON/OFF
  6. MENU available for future implementations
- 3 on-board LEDs:
  LOO On Off
  1. LM setup menu active
  2. LA Alarm condition

The following figure represents schematically the front panel of the controller:



USER SEQUENCE OF OPERATION

Machine starting:

- If OFF the machine is started pushing the ON/OFF key.
- The on LED will be lit.
- After 15 seconds of delay the system will be running.

Machine shut-down:

- If ON the machine is halted pushing again the ON/OFF key.
- The on LED will be off.

Set point change:

- Press <SET>, the LCD will ask the password input.
- Using the <UP> <DOWN> keys input the right password.
- Press <SET>, the 'MODIFY' word will appear allowing the parameter to be changed; the LCD will show the set point actual value.
- Using the <UP> <DOWN> keys modify the set point value.
- Press <SET> to store it or <ESC> to exit without memorising.

CONFIGURATION

The mother board, provided with the relevant user interface, can control up to two compressors. In a 4+ compressors chiller the mother board will be serially connected with the slave compressor boards (one per two compressors). All the interactions with the machine are made through the master board (M.B.) user interface (U.I.).

The two water temperatures probes (Tin RWT Return Water Temperature and Tout Leaving Water temperature) are connected to the MB.

SOFTWARE CONTROL CONCEPT

This procedure runs on the master board, switching all the compressors on and off according to the plant requirements:

- According to all parameters the software will control the System using a PID like control algorithm to maintain Tc to the desired Set Point. The algorithm also takes care of the running hours of any compressor, the minimum interval between two insertions of the same compressor, the minimum time between any compressor startup and the alarm status.
- Every 4 hours the more used compressor is halted and is replaced by the less used one. (Not applicable to the leader compressor).
- Each time a compressor is normally stopped (not for alarms) the pump down procedure is executed according to the set up parameters.

TEMPERATURE CONTROL

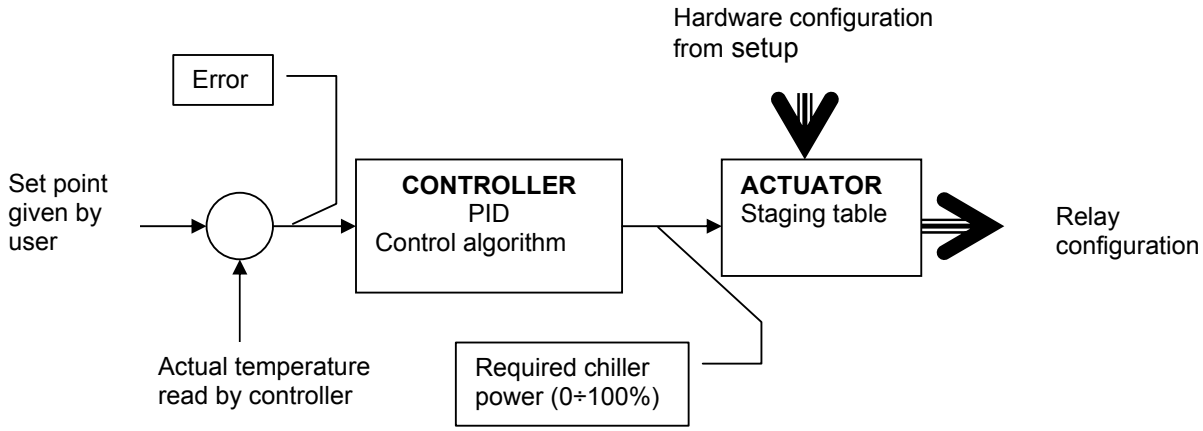
Initially, the Control on Leaving or Return Water temperature is being decided and the required water temperature set point (SP) for the plant has to be decided based on the requirement and entered in the corresponding parameters. This set point becomes the reference point for the controller for the staging logic.
Now, when the system is started up, the software starts to check al the necessary inputs (Analog) to start the unit. If the actual water temperature reading is more than the set point, the software generates an error signal. Based on this error signal, the Algorithm generates the required chillers power to the plant. Based on this the staging table, the actuator energizes the output relays to meet the load requirement.

During this process the software – also scan the Digital inputs. If any unwarranted interruption has occurred the Alarm Signal is generated and the unit is shut-off for safety purposes.

The controller also takes care of the running hours of each compressor and the status of the compressor, fan, solenoid, etc.

CONTROLLER STRUCTURE

Our method divides the problem in two tasks: the controller and the actuator.
The controller decides, given the error value and using a PID algorithm, the percentage value of the total chiller power to be given to the plant. The actuator must set the output relays status (compressor, hot gas bypass and head unloader) to best fit the amount of power required by the controller. This job is easier with a multicompressor chiller.

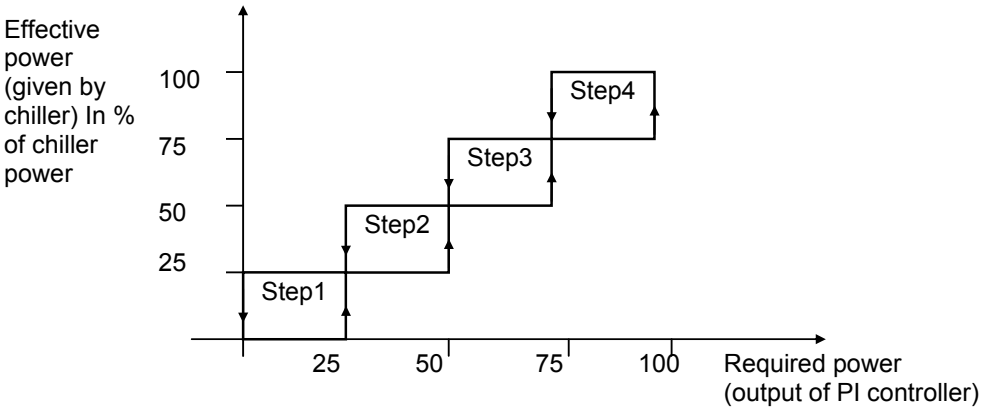


Parameters that must be set are Proportional Band (error value in °F to have 100% of the chiller power) and Integral Time (time required for the integral control to be equal to the proportional). Integral time, that takes steady state error to zero, will be set on special application requirements.

STAGING LOGIC

The following assumptions are made:

1. The Hot Gas Bypass Solenoid is only on circuit 1, and it takes out 50% of the circuit power.
2. The Head Unloader is used on 1 circuit only.
3. If the leader is fixed then it is necessarily circuit #1.
4. The Head Unloader takes out or 50% of the power or 33% of the power, according to the set up parameter **M58**.
5. When Hot Gas Bypass Solenoid is enabled, the leader circuit becomes always circuit 1 (CP1).
6. Hot Gas Bypass Solenoid is only used in the lower control step.
7. The control assumes the bigger stage configuration when the required power is equal to the bigger stage power and the smaller stage configuration when the required power is equal to the smaller stage power. Following an example for a 4 step staging.



8. When a compressor must be switched on the algorithm takes from the available compressors the less used one (not blocked by alarm or timer). This is not applicable if the set up parameter **M24** says no compressor hours equalisation.
9. When a compressor must be switched off the system takes the more used one. This is not applicable if the set up parameter **M24** says no compressor hours equalisation.
10. Maximum number of compressor is set to 8.

Compressor Switch on procedure

RECIPROCATING compressor (**M14** = 1)

- Check the minimum time before different compressor insertion (**M23**) is elapsed.
- Switch on circuit less used fan or first fan depending on setup parameter **M38**.
- Wait 20 seconds.
- Switch on compressor and liquid solenoid or Liquid Injection ports.
- Enable PI control of discharge pressure. At the beginning the output of the controller is locked to 25% in stepless control or at unloading capacity in step control.

Compressor switch on and off limitation

The table explains the system limitation to change status of compressors.
Those changes are required by the control algorithm, and are obtained through software procedures; but compressors are not always available for these changes.
A cause of compressor not availability is an alarm situation or the minimum time on or off that not elapsed.
In other situations the control algorithm needs to switch off a compressor and the compressor is blocked on: there is a minimum time between two stops' parameter in set up; this time should be elapsed before stopping the compressor.

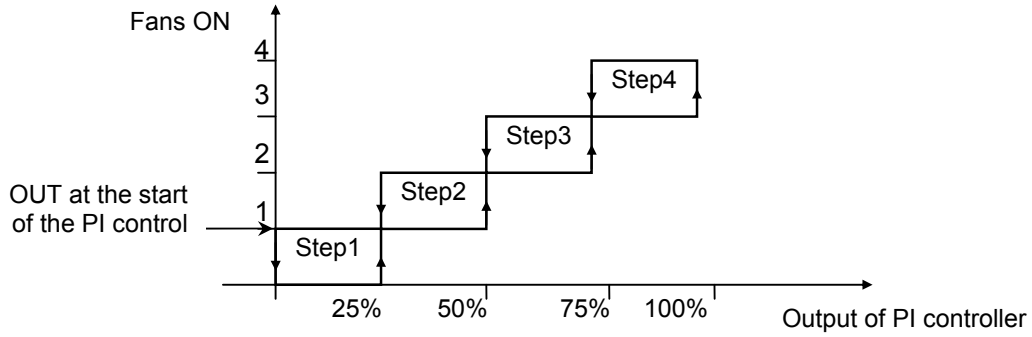
Initial compressor status	End compressor status	Procedure to be used to change status	Min time before enabling procedure
OFF	ON	Switch on	Minimum time off (**M40**) from last stop. Is the minimum time the compressor should stay off before being started again
OFF	ON with unloader	Switch on	Minimum time off (**M40**) from last stop. Is the minimum time the compressor should stay off before being started again
ON	OFF	Pump down	Minimum time on (**M41**) from last start. Is the minimum time the compressor should stay on before being stopped.
ON with unloader	OFF	Pump down	Minimum time on (**M41**) from last start. Is the minimum time the compressor should stay on before being stopped.
ON	ON with unloader	-	No limitation
ON with unloader	ON	-	No limitation

Discharge pressure control

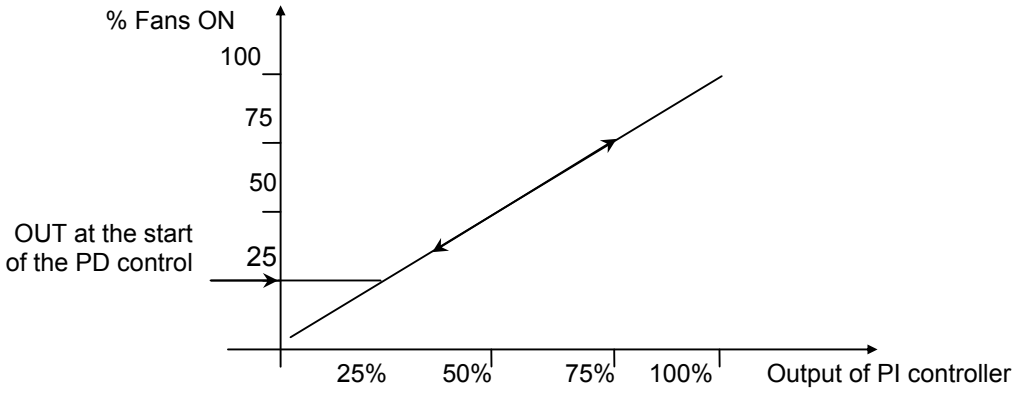
This procedure is repeated for each circuit controlling locally the discharge pressure.

- Fans are switched ON & OFF with a discrete Proportional Integral (PI) like algorithm, which also takes care to equalize the running time of each fan (Equalizing or not is determined by setup parameter **M38**).
- Option is Proportional Speed Control achieved using an analog output 0÷10 V dc that can be enabled through a set up parameter (**M34**). The max voltage for 100% fan speed is setting by setup parameter **M39** (i.e. if fan 100% output will be equal to **M39**).
- Set point is determined by set up parameter **M35**.
- Fan always starts 20 seconds before compressor (refer to compressor starting procedure).
- If the compressor is switched off the fans control algorithm will be switched OFF (forcing therefore all fans off): when the output of controller reaches zero or after the minimum OFF CP time.
- If Adaptive Control is selected (**M71** <> 0) the HU solenoid will be energized when DP > **M71**. The solenoid will be no more energized when DP < (**(M71)** - **(M72)**) if the 'minimum time on for unloader in adaptive control' (**M73**) is elapsed from the moment of energizing.

Without Proportional Speed



With Proportional Speed



Electronic Expansion valve Control

This procedure is repeated for each circuit controlling locally the superheating value; it is enabled by **M78**:

- **M78** = 0 then EEV is disabled;
- **M78** = 1 then EEV is enabled enabled through analog output;
- **M78** = 2 then EEV is enabled through serial.

The superheating value is the difference between Suction Temperature ST and Evaporating Temperature (calculated from Suction Pressure).
The parameters of the PID control are stored in EEPROM:

- **M79**: Set Point for superheating control
- **M80**: Proportional Band for EEV control
- **M81**: Integral time for EEV control
- **M82**: MOP Maximum Operating Pressure (Maximum value of Suction Pressure allowed)
- **M85**: STARTING value for EEV when the compressor starts without parzialization
- **M86:** STARTING value for EEV when the compressor starts with parzialization

MOP management

MOP is the maximum allowed value of SP: if SP > **M82** the control algorithm is bypassed and the Electronic Expansion Valve should be closed to reach the MOP value:

SP < MOP: PI control is enabled
MOP< SP < MOP + 5 PSI: the control output is locked
SP > MOP + 5: the control output decrease of 0.5%

Pulsed Hot Gas Bypass Solenoids

The Hot Gas Bypass Solenoid will be managed in pulsed mode, if setup parameter **M60 <>** 0 and the Unloading are enabled without HGBS (**M21**=2).

The following assumptions are made:

- Setup parameter **M60** is the switching time, in seconds, of HGBS.
- In every board (Master or Slave) the HGBS valve will work in pulsed mode, if at least one compressor is switched on.
- When the pulsed mode is enabled, in the first **M60** seconds, the HGBS will be switched off.
- If both compressors of the single boards are switched off, the HGBS will be switched off.

Two Barrels management

The selection of one barrel or two barrels management is made by **M16** installer setup parameter:

M16 = 0 select one barrels management;
M16 = 1 select two barrels management.

If two barrels management is enabling then the following assumptions are made:

- Evaporation temperature on the first barrel (EV1BT) is read by the TOUT probe of CP3-4 board.
- Evaporation temperature on the second barrel (EV2BT) is read by the TIN probe of CP3-4 board.
- Anti freeze alarm is checked on the temperature LWT, RWT, EV1BT, EV2BT.

LCD DATA DISPLAY

In the normal operating mode the 20 x 4 LCD displays the system status, the IN and OUT temperatures, the set point, run time of the chiller, the alarm history (e.g. list of the last 9 alarms). In addition, for each circuit:

- Suction and discharge pressure
- Compressor status
- Fan status
- Liquid line solenoid status
- Run time of compressor

The control temperature (Tc) is continuously displayed on the 3 digit LED display.

In the normal operating mode the 20X4 LCD displays:

COOLINE
AIR CONDITIONERS
LWT 24.5 RWT 31.5 °F
SP 23.5°F Cooling 100%

SP 23.5°F SYSTEM OFF

LWT : Leaving water temperature
RWT : Return water temperature
SP : Set point
% : Denotes the current % cooling demand

If UP key is pressed we show other information about the chiller

T CONTROL LWT/RWT
RT: xxxxxh HGBS:xxx
STAGE:xx CP:x HUCP:x

EV12T:xxx EV34T:xxx	Evaporators temperatures (show only if **M16** =1)

RT : Run time
HGBS : Hot gas bypass solenoid (xxx = NO/ON/OFF)
STAGE : Number of stages (x = 0…8)
CP : Number of compressor ON (x = 0….8)
HUCP : Number of compressor unload (x = 0…8)

If UP key is pressed the system shows the alarm history pages (Alarm #1 is the more recent alarm):

ALARM HISTORY
1:
2:
3:

ALARM HISTORY
4:
5:
6:

ALARM HISTORY
7:
8:
9:

To clear the alarm history press together DOWN and ESC key when the controller is in 'off' status.

When an alarm is active the following page is displayed. When the alarms are more than 1 the information is changed every 5 seconds.

ALARM
Compressor N
Description

If the alarm needs manual reset LCD shows this display:

ALARM
Compressor N
Description
Press <ESC> to reset

This is a table of shows the DESCRIPTION of the alarms that shall be displayed:

ALARM DESCRIPTION	**ALARM HISTORY CODE**
ICE HAZARD	ICE HAZARD
OIL PRESSURE LOW	CP N:OIL PRESS LOW
BREAKER FAULT	CP N:BREAKER FAULT
SSPS FAULT	CP N: SSPS FAULT
PROBE I OUT OF RANGE	CP N: PROBE I
WATER OVERTEMP	CP N:WATER OVERTEM
SUCTION PRES LOW	CP N:SUCT PRES LOW
DISCHARGE PRES HIGH	CP N:DISCH PR HIGH
DISCH PRES TOO HIGH	CP N:DIS P TOO HGH
NO WATER CIRCULATION	NO WATER CIRCULAT.
LOW OIL LEVEL	CP N:LOW OIL LEVEL
HIGH PRESS SWT FAULT	CP N:HIGH P SWITCH
SERIAL COMMUNICATION	CP N: SERIAL COMM.
NO RUN CONDITION	CP N: NO RUN
TOO MUCH PUMP DOWN	CP N: PUMP DOWN
	NO ALARM RECORDED

ALARMS

Alarms are handled only if the controller is in 'on' status. In case of system failure, the controller displays on the U.I. LCD the relevant error messages complete with the faulty circuit number. Once the alarm condition has been reset, the error messages disappear automatically or, in some particular cases remain until the ESC key is pressed (as shown in the display). When an alarm is present the General Alarm Indication relay is activated.

If manufacturer setup **M76**=7 and fans number **M33**≤2 then, when a single circuit alarm is present, the fan#3 digital output is activated (relay 11 for first circuit and relay 15 for second circuit).

Following a list of the possible error conditions:

Anti-Freeze Alarm

For single barrel systems (**M16**=0) if the lowest temperature between LWT and RWT is below (<) **M27** for more than 1 second (selectable because it may vary with percentage of additives added) or for multi barrels systems (**M16**=1) if the lowest temperature between LWT, RWT, EV12T, EV34T is below (<) **M27** for more than 1 second (selectable because it may vary with percentage of additives added):

- Switch on the general alarm indication relay
- Switch off all compressors
- Message: "ALARM ICE HAZARD "
- Manual reset through the ESC key

Oil Pressure alarm

For reciprocating compressors (**M14** = 1) the OP Oil Pressure alarm is as follows:
If the compressor is running and oil pressure – suction pressure (PO-PS) < PO_Diff_oil (**M65**) for more than Time_oil_alarm (**M66**):

- Compressor is halted without pump down procedure;
- Message: "ALARM COMPRESSOR # OIL PRESSURE LOW";
- Manual reset through the ESC key .

Compressor Magnetic Circuit Breaker

If the Circuit breaker input is high for more than 1 second:

- Compressor is halted without pump down procedure
- Message: "ALARM COMPRESSOR # BREAKER FAULT"
- Manual reset through the ESC key

Compressor Solid State Protection System SSPS (winding thermistors)

If the Thermistor input is high for more than one second:

- Compressor is halted without pump down procedure
- Message: "ALARM COMPRESSOR # SSPS FAULT"
- Manual Reset through the ESC key.

Probes Warning

If one or more probes go in underflow (short circuit) or overflow condition (open circuit):

- Compressor is halted without pump down procedure
- Message: "WARNING COMPRESSOR # PROBE X OUT OF RANGE"
- Automatic reset after the end of the alarm condition
- If it is broken the probe where the control is made (check) then
  if TC = LWT then control on RWT and new set = old set + 5°
  if TC = RWT then control on LWT and new set = old set - 5°
  automatic reset at the end of alarm condition.

Temperature Warning

If Tc > (Set_T + Delta_T_Alarm **M25**) for a period longer than t_temp_alarm (**M26**):

- Message: "ALARM WATER OVERTEMP."

Automatic reset when Tc < Set_T or manual pressing <ESC>
This alarm is disabled for the first 6 hours after the machine start.

Suction Pressure Alarm

If the suction pressure (PS < Set Alarm_PS **M63**) for more than **M64** seconds (this check is bypassed until the end of compressor minimum on time and during pump-down):

- Compressor is halted without pump down procedure
- Message: ” ALARM COMPRESSOR X SUCTION PRES LOW”
- Manual reset through the ESC key after the reset of the alarm condition

Discharge Pressure Alarm

If PD > (PD_alarm **M67**)
- Compressor is halted without pump down procedure
- Message: ” ALARM COMPRESSOR X DISCHARGE PRESS HIGH ”
- Manual reset through the ESC key

High Pressure Alarm

If the HP input is high:
- Message: ”ALARM COMPRESSOR N° X HIGH PRESSURE FAULT ”
- The system is halted
- Manual reset through the ESC key

Flow Switch Alarm

If the FL input is high for more than **M62** seconds:
- Message: ” ALARM NO WATER CIRCULATION”
- The system is halted
- Automatic reset 30 second after the end of alarm condition

Serial communication alarm

MASTER: If the serial communication with a slave is broken the master get out the slave.
- Message: ” ALARM COMPRESSOR X SERIAL COMMUNICATION”
- The system work without the error slave
- Automatic reset.

SLAVE: if the slave doesn’t receive any message for 2 minute:
- LED increases lamp frequency.
- Both the compressors are switched off.
- Automatic reset.

Set Up Error

The setup values are checked at the controller power-on procedure.
If the value of parameter number XX is out of the programmed range:
- Message: “ALARM MAKE SET UP: YXXX PRESS <ON> TO START”
  (Y: menu code (i.e. S/M/I/T/D); XXX: progressive number of parameter)
- The machine is halted.
- Manual reset through review of installer setup and controller reset (switching off and on again).

Compressor Pump down Alarm

If the compressor is in the logical state “off”, and the number of pump down in the last hour exceeds **M70**:
- Message: ” ALARM COMPRESSOR # TOO MANY PUMP DOWN ”
- The compressor is halted
- Manual reset through the ESC key

Compressor No Run Alarm

If the discharge pressure minus the suction pressure (DP-SP) does not built up a difference of 15 PSI within **M61** seconds then:
- Message: ” ALARM COMPRESSOR # NO RUN ”
- The compressor is halted
- Manual reset through the ESC key

EEV board Serial communication alarm

If the EEV board is connected via serial line (**M78=**2) and the communication is broken for more 30 seconds, then:
- Message: ” ALARM COMPRESSOR N.X EEV BOARD ERROR”;

- The compressor is halted
- Automatic reset.

Fan Protection Alarm

If the FP digital input is active:

- Message: ” ALARM COMPRESSOR N.X FAN PROTECTION”;
- The compressor is not halted (it is a warning, not alarm)
- Automatic reset.

SYSTEM SETUP

Set Point Change

The <SET> key allow the user to modify (knowing the user password **M2**), through the <UP> <DOWN> keys the control temperature set point (Set_T). The new value will be accepted upon pressing again the <SET> button. The set point modifies procedure is as follow:

- Press <SET>, the LCD will ask the password input
- Using the <UP> <DOWN> keys input the right password (it is possible to change the value through the **M2** parameter of the installer setup)
- Press <SET>, the ‘MODIFY’ word will appear allowing the parameter to be changed; the LCD will show the set point actual value
- Using the <UP> <DOWN> keys modify the set point value
- Press <SET> to store it or <ESC> to exit without memorising

Cod.	Description	LCD Display Description	min	max	default	m.u.
S1	Set point for Temperature Control	SET POINT FOR TEMPERATURE CONTROL	32	90	40	°F
S2	Second set point for Temperature Control	SET POINT II FOR TEMPERATURE CONTROL	32	90	0	°F
S3	Capacity demand limit of unit power (100 = no upper limit)	UPPER DEMAND LIMIT (100=DISABLED)	1	100	100	%
S4	Language (0=English, 1=Deutsch, 2=Italian)	LANGUAGE 0=EN 1=DE 2=IT	0	2	0	

REMOTE MONITORING SYSTEM

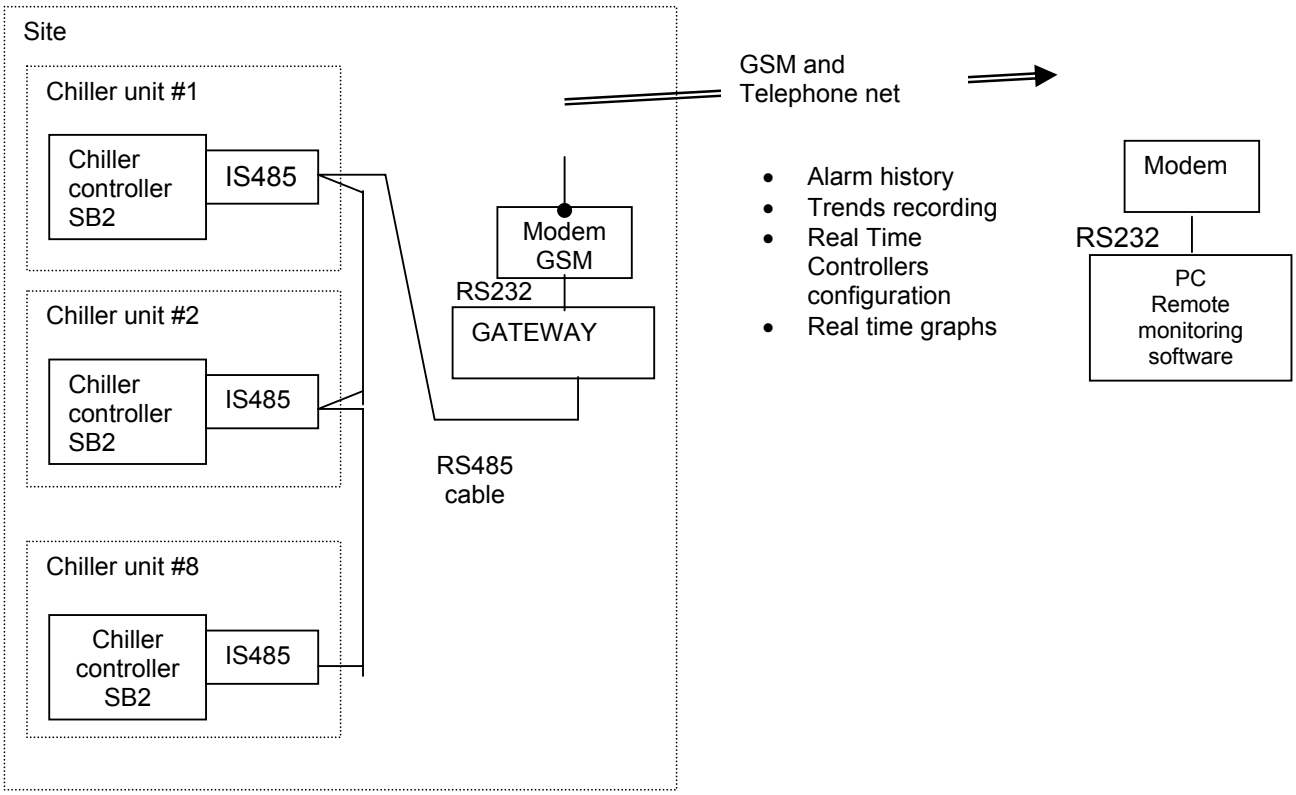
The Mother board can be equipped with an additional serial interface board and a special firmware release which allows to connect it, via an appropriate Gateway (supplied by us), to a local supervising PC or, through a Modem, to a remote PC.
The information’s exchanged are:

- Status of the Controller (every digital outputs of each compressor)
- Alarm eventually occurred with description
- User SETUP (remotely modifiable) dump
- Real time temperatures and pressures values
- Real time analog outputs values
- Suction temperature, Superheat and integral part of EEV control values
- Digital input and output configuration
- Start, Stop, Load Setup and Alarm Reset command

From the PC side appropriate software allow to easily view in tabular or graphic format these data as well as to interact with the board’s setup.

The possibility to remotely connect via modem the System to a centralized maintenance center helps to ensure a prompt and money/time saving reply to the most common operating failures, avoiding in most of the cases the on-site intervention.

Remote Monitoring through gateway



TESTING FEATURES

Some testing features are embedded in the software to consent a manual control of the board hardware.
To access the test mode and to change the kind of test it is used the dip switches (Ref. S1) on the NG3 board.

HARDWARE TEST MODE

To enter hardware test mode:

- switch board off
- set dip switch address to 7 (dip switch 1..3 ON; dip switch 4 OFF)
- switch board on

The board will act as a master with address #1, and the user interface is active to switch from one test mode to the other.

There are 4 different hardware tests mode, and it is possible choose the test mode with <ON OFF> key:

1. RELAY ROTATION
   - all relay will switch on and off with 1 second delay one after the other;
   - analog output will swing from 0 to 10 V one after the other;
2. ALL RELAY ON
   - all digital output relay are energized;
   - analog output are at 10 V
3. INPUT -> OUTPUT
   - digital input are copied on relay output (e.g. if D1 input is energized then Relay 1 contact O1C1 will be closed and so on)
4. ANALOG INPUT
   - The screen shows the values of Analog Input channels;
   - The values are shown in the following order:
     Second row: S1, D1, O1, ST1
     Third row: S2, D2, O2, ST2
     Fourth row: TAE, RH, TOUT, TIN
5. RTC TEST
   - The screen shows the actual parameters of Real Time Clock (RTC)
6. HW KEY TEST
   - The screen displays the information about the communication with HKEY external module

7. USER TEST
   - All led are switched on, display shows “8.8.8.” and every pixel of LCD display is black;

To exit the test mode:
- Switch board off;
- reset dip switch address
- switch board on

SOFTWARE TEST MODE

To enter software test mode:
- Switch board off;
- set dip switch address to 15 (all dip switch ON)
- switch board on

The board will act as a master with address #1, and the user interface is active, but the unit can not be switched on. During software test mode all eeprom parameter can be changed. The analog input values are shown with no final calibration, so temperatures are measured in ohm (like output of PTC probe) and pressures are measured in 0-100% from the 4÷20mA of the input range.

To exit the test mode:
- Switch board off
- Reset dip switch address
- switch board on

I/O CHANNELS

ANALOG INPUT

Definitive	Description	Range
S1	Suction Pressure (first circuit)	4 - 20 mA
D1	Discharge pressure (first circuit)	4 - 20 mA
O1	Oil pressure (first compressor)	4 - 20 mA
ST1	Suction Temperature (first circuit)	PTC (-10 ÷ +50 °C)
TOUT	Leaving Water Temperature (used only in mother board - Outlet temperature or in multi barrels systems with **M69 =1** - EV12T)	PTC (-10 ÷ +50 °C)
S2	Suction Pressure (second circuit) (not used with twin compressor)	4 - 20 mA
D2	Discharge pressure (second circuit) (not used with twin compressor)	4 - 20 mA
O2	Oil pressure (second compressor)	4 - 20 mA
ST2	Suction Temperature (second circuit) (not used with twin compressor)	PTC (-10 ÷ +50 °C)
TIN	Returning Water Temperature (used only in mother board - Inlet Temperature or in multi barrels systems with TBD =1 - EV34T)	PTC (-10 ÷ +50 °C)
TAE	Not used	PTC (-10 ÷ +50 °C)
RH	Not used	4 - 20 mA

ANALOG OUTPUT

(0÷10V powered by board; + positive, - negative)

Def.	MNEM.	Description	Range
AO1	EXPV1	Electronic controlled Expansion Valve (1st circuit)	0 -10 V
AO2	EXPV2	Electronic controlled Expansion Valve (2nd circuit) (not used with twin compressor)	0 -10 V
AO3	FSC1	Fan Speed Control (1st circuit)	0 -10 V
AO4	FSC2	Fan Speed Control (2nd circuit) (not used with twin compressor)	0 -10 V

DIGITAL INPUT

Input at 115/230 V AC, power supply given from the auxiliary circuit.

Definitive	MNEM.	Description
AC		Common for Digital Input
A1	TH1	SSPS (Thermistors) (first compressor)
A2	CB1	MT Circuit breaker (first compressor)
A3	O1	Oil level alarm (first compressor); (only for screw compressor)
A4	HP1	High Pressure Switch (first compressor)

A5	FP1	
A6	TH2	SSPS (Thermistors) (second compressor)
A7	CB2	MT Circuit breaker (second compressor);
A8	O2	Oil level alarm (second compressor); (only for screw compressor)
A9	HP2	High Pressure Switch (second compressor)
A10	FP2	Fans MT protection (second circuit)
A11	FL	Flow switch (used only in mother board)
A12	EXEN	External Enable
A13	EMERGENCY	Emergency Mode Enable
A14		Spare
A15	TBD	Pump 1 MT protection; TBC
A16	TBD	Pump 2 MT protection; TBC
A17	TBD	Available TBC
A18	TBD	Available TBC
A19	TBD	Available TBC
A20	TBD	Available TBC

DIGITAL OUTPUT

Relays (250 V AC, (8) 5 TBC A)

Definitive	MNEM	Description
1O 1C	CP1	Compressor 1
2O 2C	SOL1 / ECO1	Refrigerating fluid solenoid valve or ECO port (first circuit)
3O 3C	HD1	Head discharge (i.e. compressor unloader) first compressor
4O 4C	CP2	Compressor 2
5O 5C	SOL2 / ECO2	Refrigerating fluid solenoid valve or ECO port (second circuit);(not used with twin compressor)
6O 6C	HD2	Head discharge (i.e. compressor unloader) second compressor
7O 7C	HGBS	Hot Gas Bypass Solenoid (used only in mother board)
8C 8NO 8NC	ALL	General Alarm Remote indication (repeater)
9O	FA1_1	Fan # 1 (first circuit)
10O	FA2_1	Fan # 2 (first circuit)
C		Common contact for relay 9 to 12
11O	FA3_1	Fan # 3 (first circuit) / LIE1 (Liquid Injection on ECO);
12O	FA4_1	Fan # 4 (first circuit) / LIS1 (Liquid injection on Suction) / LIE1 (Liquid injection on ECO) / LIS1 + LIE1
13°	FA1_2	Fan # 1 (second circuit); (not used with twin compressor)
14°	FA2_2	Fan # 2 (second circuit); (not used with twin compressor)
C		Common contact for relay 13 to 16
15°	FA3_2	Fan # 3 (first circuit); / LIS1 (Liquid injection on Suction) / LIE1 (Liquid injection on ECO) / LIS1 + LIE1 (not used with twin compressor)
16°	FA4_2	Fan # 4 (second circuit) / LIS2 (Liquid injection on Suction) / LIE2 (Liquid injection on ECO) / LIS2 + LIE2 (not used with twin compressor)
17O 17C	TBD	Pump1 TBC
18O 18C	TBD	Pump2 TBC Cooler Heater Wrapped

For connection details, refer to the wiring diagram.

MALFUNCTIONS AND CORRECTIVE ACTIONS

1) Controller does not respond to keyboard

a) Check serial cable integrity.
b) Check serial cable connections on both the User Interface Board and the Main Board.
c) Check correct and tight insertion of jumpers TU1 and TD1 on the User Interface Board, main and/or auxiliary board.
d) Check dip switches and integrity on the User Interface Board.

2) Several analog values reading incorrectly

a) Check correct and tight connection of the probes to the board.
b) Check the probe cable: test for short-circuit.
c) The pressure transducer probe is a 4-20mA transmitter check the polarity of the connection on the Board.
d) Check if the power supply voltage is into the specified limits: 24Vac +/- 10%.
e) The temperature probe is a PTC sensor disconnect it from the board and measure its resistance that is 1000 ohm at 25°C or 1200 ohm at 50°C.
f) Check jumper configuration (see the respective wiring diagram).

3) Digital input reading incorrectly

a) Check if the auxiliary 220 Vac voltage is present in the electrical box.
b) Check if the AC unit on the Board is correctly connected to one of the 220 Vac terminals in the electrical box.
c) Check if A1/ A20 inputs are correctly connected with respect to the cabling diagram of the electrical box.

4) No LCD display lit or erratic display behaviour

a) Check serial cable integrity.
b) Check serial cable connections on both the User Interface Board and the Main Board.
c) Check correct and tight insertion of jumpers JU1 and JU2 on the Main Board.
d) Check correct and tight insertion of jumpers TU1 and TD1 on the User Interface Board, main and /or auxiliary board.
e) Adjust display intensity by rotating trimmer RV1 counter-clockwise (from the back side of the board).

5) No LED H1 blinking light on 1NG or OBI Board

a) Check power supply cable and connection.
b) Check if the power supply voltage is into the specified limits: 24Vac +/- 10%.
c) Check for fuse F1, replace with 1AT/ 250V if blown.

6) Auxiliary board not responding to commands

a) Check if LED H1 on Auxiliary board is blinking, if not go to point (6).
b) Check serial cable integrity.
c) Check serial cable connections on both the Main and the Auxiliary boards.
d) Check that jumpers JU1 and JU2 on the Auxiliary boards are not installed.
e) Check correct and tight insertion of jumpers TU1 and TD1 on the User Interface Board, main and/ or auxiliary board.

7) Analog Outputs not responding

a) Check Analog Output cables integrity (for short-circuit).
b) Check Analog Output cabling and connections.
c) Check if the power supply voltage is into the specified limits: 24VAC +/- 10%.
d) Check the fuse F1, replace with 1AT/ 250V if blown.
e) Check jumpers and dip switch according to respective wiring diagram.

8) Digital Outputs not responding

a) Check Digital Output cables integrity (no short-circuit, no open-circuit).
b) Check Digital Output cabling and connections.
c) Check if the power supply voltage is into the specified limits: 24VAC +/- 10%.
d) Check the fuse F1, replace with 1AT/ 250V if blown.

9) Serial Communications with Remote Monitoring Control not Functioning

a) Check the serial cable connected on plug-in board IS-485 mounted on the Main Board.
b) Check if the plug-in board is correctly mounted on the Main Board.
c) Check if jumpers X5 and X6 on the plug-in board IS-485 are correctly installed.
d) Check if jumpers X17 and X18 on the GATEWAY board are correctly installed.

APPENDIX

START - UP AND COMMISSIONING CHECK LIST FOR CHILLERS

PRE -START- UP INSPECTION FOR INSTALLATION

Description	Yes	No
1. Ensure the presence of vibration isolators.		
2. Check the flexible hose connections on chilled water lines.		
3. Ensure the water flow switches are in correct locations.		
4. Ensure that strainer is installed on chilled water line.		
5. Ensure that balancing valves, globe valves, motorized valves etc are installed as per the requirement.		
6. Ensure the presence of pressure gauges, temperature gauges, flow meter whatever applicable.		
7. Ensure water flow switch and pump starter are interlocked with control circuit.		
8. Ensure that the chilled - water pumps are of the recommended capacity (GPM, Head etc).		
9. If there's more than one chiller installed, ensure proper space clearance between chillers and controls inter-locking.		

PRE - START- UP INSPECTION FOR EQUIPMENT

Description	Yes	No
1. Visual inspection of the equipment and accessories for damages during transportation / installation.		
2. Ensure that chiller power supply nameplate rating (voltage etc) meets with the requirements.		
3. Ensure that UVM is installed and set it as per the design voltage.		
4. Check and tighten all wiring in control panel.		
5. Ensure that the control panels have proper schematic diagrams.		
6. Ensure compressor mounting retainer brackets are removed and adjust the bolts.		
7. Ensure that all the condenser fan motor propellers are tightened.		
8. Check whether the temperature and pressure gauges are duly calibrated.		
9. Check proper grounding of the unit.		

PREPARATORY STEPS FOR START-UP

Description	Yes	No
1. Disconnect power supply to the unit.		
2. Disconnect wires to the compressor motor for dry run test.		
3. Ensure pressure switch settings are correct.		
4. Switch on power to the control panel.		
5. Check whether crankcase heater works.		
6. Ensure correct direction of condenser fan motor rotation.		
7. Set the temperatures on controller as per requirement.		
8. Carry out dry run test.		
9. Ensure that crankcase heater is kept energized for min. 24 hours.		

STEPS FOR START-UP & COMMISSIONING

Description	Yes	No
1. Switch on the chilled water pump.		
2. Ensure the water-flow is as per design data.		
3. Ensure that the flow-switches are functioning properly.		
4. Switch on the AHUs to create load.		
5. Check motorized valves operation.		
6. Open all the refrigerant circuit valves.		
7. Ensure correct oil level in the compressor.		
8. Attach all the required testing meters/ inspection gauges to monitor operational parameters during the commissioning process.		
9. Switch on the chiller.		
10. Start and operate each compressor separately and record the amps, pressure, temperatures in the refrigerant and water lines.		
11. Check the compressor oil level in each compressor after one hour of operation.		
12. Visual check and acid test of compressor oil after one hour of operation.		
13. Repeat the process for every compressor in the chiller.		
14. On satisfactory completion of the above, start the system for full operation.		
15. Check the superheat.		
16. Check the sub-cooling.		
17. Check whether the 'leaving-water' temperature is as per design.		
18. Check the water pressure drop across the chiller barrel (Δ P).		
19. Check the temperature difference (water-in/ water-out) in chiller barrel (Δ T).		
20. Simulate safety cut-outs functions and ensure its proper operation.		
21. Ensure full load is available; if so, leave the system on for 24 hours.		
22. Monitor and log performance, etc.		

Note :
Check out report (4 pages) provided in this manual to be completed for each unit separately. A certified copy of the check out report must be forwarded to Zamil Head Office, Dammam in order to avail the warranty.

CHECK OUT REPORT

IMPORTANT: This check out report must be completely filled out and signed (on page 4).In order for the warranty to be valid, send copy of the report to Chiller Eng'g. Manager, Zamil Airconditioners, P.O. Box 14440, Dammam 31424, Saudi Arabia.

INSTRUCTIONS:

The format of this report is such, that it can be used for a wide range of equipment. Therefore, when filling out this report, complete only the applicable parts. If you have any questions when filling out this form or if you encounter any problems starting the equipment, contact the nearest Zamil office or its representatives for assistance.

1. Use one Check out report for each unit.
2. If equipment is not operational, complete till middle of page 3. If equipment is operational, complete all applicable portions of this report.
3. If there is not enough space available for special equipment, readings, etc; list these on a separate sheet.
4. Do not rely on field installed gauges, thermometers or other meters for your readings. Use only calibrated gauge manifolds and meters for your readings. When checking temperatures, check that the thermometers or thermocouples are insulated to ensure accurate readings.
5. Final readings should be taken when unit is running at maximum capacity.
6. Explain operating conditions at time of test, i.e.; compressors fully loaded, hot gas bypass operating, compressor unloaded etc.
7. If possible, furnish photographs of installation or problem (i.e.control panel, leaking etc.). Make appropriate comments on additional sheets as necessary as follows:

- Product comments
- Installation comments
- Operational comments

Job Name & Address_____

Customer_____

Address_____

NAME PLATE DATA

Unit Model #_____ Serial #_____

Factory order #_____ Engineering File #_____

Compressor model 1._____ 2._____ 3._____ 4._____ 5._____ 6._____ 7._____ 8._____

Serial numbers 1._____ 2._____ 3._____ 4._____ 5._____ 6._____ 7._____ 8._____

Codenser details Coil Material_____ Coating type (if any)_____

Condenser fan motor model _____ Total Qty._____

Evaporator/ Cooler model 1._____ 2._____

Evaporator/ Cooler serial # 1._____ 2._____

TXV/ EXV manufacturer 1._____ 2._____ 3._____ 4._____ 5._____ 6._____ 7._____ 8._____

TXV/ EXV model 1._____ 2._____ 3._____ 4._____ 5._____ 6._____ 7._____ 8._____

INSTALLATION DATA

Refrigerant type_____

Application: ☐ Air Conditioning ☐ Refrigeration ☐ Process cooling ☐ Other_____

Liquid line Heat exchanger (economizer) installed? Yes ☐ No ☐

Liquid line filter drier installed Yes ☐ No ☐

Liquid line solenoid valve installed? Yes ☐ No ☐

Liquid line sight glass installed? Yes ☐ No ☐

Water flow through chiller barrel: Parallel flow ☐ Counter flow ☐

Cooler flow : # 1 _____ ΔP_____ GPM

Cooler flow : # 2 _____ ΔP_____ GPM

Cooling medium is : ☐ Water ☐ Brine_____% by wt. ☐ Ethylene Glycol_____ % by wt.

REFRIGERANT LEAKS: Thoroughly inspect unit for refrigerant leaks. If any are found, check this block and explain in detail on a separate sheet. Contact your nearest Zamil office for assistance.

SYSTEM LOAD

Is a full load available during start up? Yes ☐ No ☐

If full load is not available note under customer discrepancies on page 4 of this Check out report and advise customer that a return trip at his expense will be required.

ELECTRICAL NAMEPLATE DATA

Unit power supply (v-ph-hz)_____ Minimum circuit ampacity_____

Control voltage_____

Compressor start : Part Wind start ☐ Star delta start ☐

Compressor starter/ contactor model #_____ O.L relay model #_____

Condenser fan contactor model #_____ O.L relay/ breaker model #_____

Is unit wired for pumpdown?_____

*Is flow switch installed and interlocked with control circuit_____

*Is chilled water pump interlocked with control circuit?_____

Have ALL wiring connections been checked for tightness?_____

Actual supply voltage (unit shutdown) L1 - L2_____ L2 - L3_____ L3 -L1_____

Crankcase heater operating? Yes ☐ No ☐

Wiring diagram #_____

***IMPORTANT NOTE:**

On all chiller applications, a flow switch and / or chilled water pump interlock must be installed or warranty will be void. DO NOT leave unit operating without either or both of these safety features.

UNIT SPECIFICATIONS

This information can be obtained from concerned sales engineer or the service manager.

Refrigerant suction temperature_____ Condensing temperature_____ Tons_____

Chiller :_____ GPM_____ Inlet temperature_____ Outlet temperature_____

PRESSURE SETTINGS

Description	CR1		CR2		CR3		CR4		CR5		CR6		CR7		CR8	
	CUT-IN	CUT-OUT	CUT-IN	CUT-OUT	CUT-IN	CUT-OUT	CUT-IN	CUT-OUT	CUT-IN	CUT-OUT	CUT-IN	CUT-OUT	CUT-IN	CUT-OUT	CUT-IN	CUT-OUT
HP switch																
LP switch																
OP switch																
HP transducer																
LP transducer																
OP transducer																
PUMP DOWN																
FAN # 1																
FAN # 2																
FAN # 3																
FAN # 4																
FAN # 5																
FAN # 6																
FAN # 7																
FAN # 8																
HGBP																

TEMPERATURE SETTINGS

Description	CR1		CR2		CR3		CR4		CR5		CR6		CR7		CR8	
	CUT-IN	CUT-OUT	CUT-IN	CUT-OUT	CUT-IN	CUT-OUT	CUT-IN	CUT-OUT	CUT-IN	CUT-OUT	CUT-IN	CUT-OUT	CUT-IN	CUT-OUT	CUT-IN	CUT-OUT
Discharge temperature																
Freeze protectior																
Suction superheat																

OPERATING INFORMATION

ELECTRICAL DATA

COMPRESSORS

	VOLTAGE			AMPERAGE*		
	L1-L2	L2-L3	L3-L1	L 1	L 2	L 3
1A / 1B						
2A / 2B						
3A / 3B						
4A / 4B						
5A / 5B						
6A / 6B						
7A / 7B						
8A / 8B						

CONDENSER FAN MOTORS

	VOLTAGE			AMPERAGE*		
	L1-L2	L2-L3	L3-L1	L 1	L 2	L 3
# 1						
# 2						
# 3						
# 4						
# 5						
# 6						
# 7						
# 8						
# 9						
# 10						
# 11						
# 12						
# 13						
# 14						
# 15						
# 16						
# 17						
# 18						
# 19						
# 20						
# 21						
# 22						
# 23						
# 24						

Notes:

* If two starters are used (part wind, windings A & B), give amperage on all legs.

CR - Compressor refrigeration circuit.

All temperature and pressure units in °F and PSIG respectively unless otherwise noted.

TEMPERATURE READINGS

LOCATION	CR1	CR2	CR3	CR4	CR5	CR6	CR7	CR8
1. Discharge line at compressor								
2. Suction line at compressor								
3. Saturation temperature corresponding to suction pressure								
4. Suction superheat (2 minus 3)								
5. Liquid line entering sub-cooler (economizer)								
6. Liquid line leaving sub-cooler (economizer)								
7. Saturation temperature corresponding to discharge pressure								
8. Liquid line leaving condenser								
9. Condenser subcooling (7 minus 8)								
10.Condenser air on								
11.Condenser air off								
12.Chilled water/ brine/ glycol in								
13.Chilled water/ brine/ glycol out								
14.Ambient temperature								

NOTE : Be sure that all the thermometers or thermocouples are strapped tightly to lines and insulated for accurate readings.

PRESSURE READINGS

LOCATION	CR1	CR2	CR3	CR4	CR5	CR6	CR7	CR8
Discharge pressure								
Suction pressure								
Net oil pressure								
Liquid line pressure at pump down solenoid valve								
Liguid line entering sub-cooler (economizer)								

Oil level #1 ◯ #2 ◯ #3 ◯ #4 ◯ #5 ◯ #6 ◯ #7 ◯ #8 ◯
(Compressor sight glass)

Oil color #1_____#2_____#3_____#4_____#5_____#6_____ #7_____ #8_____

Acid test #1_____#2_____#3_____#4_____#5_____#6_____ #7_____ #8_____

This check out report is to be completely filled out and sent to Chiller Engineering Manager, Zamil Airconditioners, P.O. Box 14440, Dammam 31424, Saudi Arabia.

Field service engineer_____

Contractor Name_____

Address_____

This report filled out by _____ Date_____

PURCHASE ACCEPTANCE OF ZAMIL START UP

We, the undersigned, agree that this start - up meets with our approval pertaining to the performance of the equipment and to the training received by our operating and service personnel.

JOB SITE DISCREPANCIES - OWNER/ CONTRACTOR RESPONSIBILITY : Signature :_____

_____ Title :_____

_____ Date :_____

PREVENTIVE MAINTENANCE REQUIREMENT FOR ZAMIL ASQ- SERIES SCREW CHILLERS

PROCEDURE	WEEKLY	QUARTERLY	SEMI-ANNUALLY	YEARLY
COMPRESSORS:				
1. Check system operating pressures and temperatures.	x			
2. Check oil level.	x			
3. Check condition of oil.	x			
4. Check liquid injection operation.		x		
5. Check operation of capacity control device (slider & solenoid valves)		x		
6. Check crankcase heater operation.		x		
7. Sample compressor oil.				x
8. Check integral check valve			x	
9. Check pressure relief valve and roller bearings				x
REFRIGERANT FLOW CIRCUIT:				
1. Check for pipework damage.		x		
2. Check filter drier		x		
3. Check for leaks (complete leak check)			x	
4. Check liquid line sight glass / moisture indicator	x			
5. Check suction superheat at compressor	x			
6. Check condenser liquid subcooling	x			
7. Check expansion valves, solenoid valves and check valves.		x		
8. Check economizer operation.		x		
AIR COOLED CONDENSERS:				
1. Check condenser coils for dirt / debris and clean as required.		x		
2. Check fans and fan guards.		x		
3. Check fan motor bearings.			x	
COOLER:				
1. Check water flow.		x		
2. Check water pressure drop & cooler efficiency.		x		
3. Check cooler heater operation (if provided).		x		
4. Check water pH / glycol strenth.				x
ELECTRICAL & CONTROL SYSTEM:				
1. Check condition of control panel and all components		x		
2. Check power and control wiring.		x		
3. Check sensor locations.		x		
4. Check mechanical HP cut-outs and water flow switch operation.		x		
5. Check under voltage monitor and main disconnect.		x		
6. Check tightness of all wiring connections				x
7. Check compressor contactors/ overloads/ breakers.				x
8. Check fan contactors / breakers.				x
9. Check sensor / transducer calibration				x
10. Check compressor motor protectors.				x
11. Check contactor contacts.				x
MICROPROCESSOR CONTROLLER:				
1. Check fault history	x			
2. Check operating set points.		x		
3. Check HP and OP safety cut-out funtion.		x		
4. Check pump-down function.			x	
5. Check capacity load / unload function.			x	
6. Check fan control function.			x	
7. Check ambient cut-out function.			x	
UNIT GENERAL:				
1. Check thermal insulation on cooler and piping.		x		
2. Check vibration isolators, repair/replace as necessary		x		
3. Check unit structure for loose bolts/ screws and tight as necessary				x
4. Check for rusted/dented/ damaged body parts and repair/ repaint as necessary.				x

NOTES:

1. The above proceedures should be carried out by suitably qualified personnel only. A record of these procedures being successfully carried out must be maintained by the equipment owner as a proof of adequate maintenance which may be required later for warranty validation purposes.
2. For guidelines and detailed information pertaining to the above maintenance procedures, refer relevant sections in the maintenance manual.

TROUBLESHOOTER'S GUIDE TO CHILLER PROBLEMS

(To be used by suitably qualifed personnel only)

SYMPTOMS	POSSIBLE CAUSE	CORRECTIVE ACTION
1. Unit will not start, no display on microprocessor controller panel.	Main disconnect switch open.	Close switch, if safe to do so.
	Faulty wiring or loose connections.	Repair wiring or connections.
	UVM tripped-Fautly power supply.	Contact electric utility company to investigate and rectify the problem.
	Control switch OFF.	Switch ON, if safe to do so.
	No 24VAC supply to control board.	Check control transformers and power supply to control board.
	Controller defect or problem with serial cable integrity and connections.	Refer section on "Microprocessor Controller" in this manual and take suitable corrective action.
	Jumper PRG is closed	Remove jumper
2. Unit does not run. Possible Controller message: ALARM MASTER NO WATER CIRCULATION OR ALARM MAKE SET UP: YXXX PRESS <ON> to start	No liquid flow through the cooler, flow switch contacts are not made and control circuit is open.	Ensure that pumps are running, valves are correctly set and flow is established. Check that flow switch is functional and is installed properly. Note: Pump starter is interlocked into the chiller control circuit.
	Incorrect setup values on the controller.	Incorrect parameters should be reset correctly on the controller.
3. Compressor does not run (Hum or No Hum). Possible Controller message: ALARM COMPRESSOR N. # NO RUN	Compressor circuit breaker open.	Close breaker and check circuit.
	Faulty wiring or loose connections.	Repair wiring or connections.
	Low voltage, single phasing or phase imbalance.	Determine reason and correct.
	Defective contactor coil or contacts.	Repair/ replace contactor.
	Control circuit open.	Locate cause and repair.
	Shorted or grounded motor windings.	Repair/ replace compressor.
	Burntout compressor motor (open circuit).	Repair/ replace compressor.
	Internal compressor mechanical damage.	Repair/ replace compressor.
4. Compressor starts and runs, but trips. Possible Controller message: ALARM COMPRESSOR N.# BREAKER FAULT OR ALARM COMPRESSOR N. # SSPS FAULT OR ALARM COMPRESSOR N. # HIGH PRES. SWT FAULT (represents overload relay fault)	Improperly wired.	Check wiring diagram and rewire properly.
	Low voltage, single phasing or phase imbalance.	Determine reason and correct.
	Bad contactor contacts.	Replace contacts.
	Overload Protector defective.	Check and replace overload protector.
	Shorted or grounded motor windings.	Repair / replace compressor.
	Excessive suction or discharge pressures.	Refer relevant sections in this guide and take corrective action.
	High discharge/ oil temperature, insufficient oil charge or suction superheat too high.	Add sufficient amount of proper compressor oil or check suction superheat is within range.
	Compressor too hot- indadequate compressor cooling (shortage of refrigerant).	Check and maintain proper refrigerant charge.
	Tight bearings or mechanical damage in compressor.	Repair/ replace compressor.

SYMPTOMS	POSSIBLE CAUSE	CORRECTIVE ACTION
5. Compressor runs ok, but short cycles. (Too frequent stopping and starting). Possible Controller message:	Control differential too small.	Reset differential in accordance with job conditions.
	Rapid fluctuations in cooling demand or chiller is oversized.	Study the load profile carefully and take sutiable action.
ALARM COMPRESSOR N.# TOO MANY PUMP DOWN.	Capacity control slider/ solenoid valves not working properly.	Check slider operation and its solenoid valves. Ensure that compressors modulate capacity correctly.
6. Unit / compressors operate continuously and system is short of capacity (water temp. high).	Shortage of refrigerant.	Repair leak and recharge.
	Insufficient compression - defective compressor.	Check compressor for internal damage, repair/ replace compressor.
	High suction pressures.	Refer section 10 in this guide and take corrective action.
Possible controller message: ALARM MASTER WATER OVERTEMP.	Excessive load or chiller is undersized.	Study the load profile/ demand carefully and take sutiable action.
	Noncondensables (air) in system.	Purge out non condensables.
	Wrong expansion valve superheat setting.	Adjust superheat setting.
	Dirty or defective expansion valve.	Clean/ repair/ replace expansion valve.
	Restriction in refrigeration circuit (eg: Clogged filter drier, liquid line solenoid valve not operating correctly etc).	Locate and remove. (if clogged filter drier, replace drier elements/cores, if LLSV is defective - repair/ replace it).
	Dirty condenser coil.	Clean coil.
	Reduced cooler performance (Cooler tubes fouled retarding heat transfer.)	Check cooler efficiency and Clean water side of cooler.
7. Unit/ Compressors operate continuously and there is too much cooling (water temp. too low)	Temperature setting too low.	Check setting and reset accordingly.
	Contactor contacts stuck or weld shut.	Replace contacts.
	Low suction pressures.	Refer section 11 in this guide and take corrective action.
Possible controller message:	Water temperature drops below the programmed lower limit faster than the unit can reduce its capacity.	Variation in water flow through cooler. Locate cause and take corrective action.
ALARM MASTER FREEZE PROTECTIONAL.	Capacity control slider/ solenoid valves not working properly.	Check slider operation and its solenoid valves. Ensure that compressors modulate capacity correctly.
8. Discharge pressure too high.	Refrigerant overcharge.	Remove/ purge the excess refrigerant charge.
Possible Controller message:	Non condensables (air) in system.	Purge out non condensables or evacuate the system, as required.
ALARM COMPRESSOR N.X DISCHARGE PRES. HIGH.	Dirty condenser coil.	Clean coil.
	Excessive condenser entering air temperatures.	Check unit location, short circuitng of condenser discharge air and take suitable corrective action.
	Restriction in discharge line.	Locate and take corrective action.
	Poor airflow through condenser coils.	Check for airflow restrictions and damaged fins, check for correct fan/ motor operation and direction of rotation (refer section 16 in this guide and take corrective action).
9. Discharge pressure too low.	Shortage of refrigerant.	Repair leak and recharge.
	Insufficient compression - defective compressor.	Check compressor for internal damage, repair/ replace compressor.
	Low suction pressures.	Refer section 11 in this guide and take corrective action.
	Low ambient temperatures.	Check the setting and operation of fan cycling for head pressure control.

SYMPTOMS	POSSIBLE CAUSE	CORRECTIVE ACTION
10. Suction pressure too high	Excessive load or chiller is undersized.	Study the load profile/ demand carefully and take corrective action.
	Insufficient compression - defective compressor.	Check compressor for internal damage, repair/ replace compressor.
	Overfeeding of expansion valve.	Check superheat setting, and take suitable corrective action.
	Expansion valve stuck open.	Repair/ replace valve.
	High discharge pressures.	Refer section 8 in this guide and take corrective action.
11.Suction pressure too low. Possible Controller message: ALARM COMPRESSOR N.# SUCTION PRES. LOW.	Shortage of refrigerant.	Repair leak and recharge.
	Low load on cooler (water temp. low or reduced water flow).	Locate cause and take corrective action.
	Wrong expansion valve superheat setting.	Adjust superheat setting.
	Dirty or defective expansion valve.	Clean/ repair/ replace expansion Valve.
	Reduced cooler performance (cooler tubes fouled retarding heat transfer).	Check cooler efficiency and clean water side of cooler.
12. Compressor is noisy.	Improper compressor mounting.	Repair/ replace compressor mounts.
	Liquid flooding back to compressor.	Refer section 13 in this guide and take corrective action.
	Oil slugging or excessive oil in system.	Remove excess oil from the system.
	Compressor internal parts broken or worn out.	Repair/ replace compressor.
	Insufficient lubrication.	Check oil level & condition and take corrective action.
13. Suction line sweating excessively or frosted. (liquid refrigerant flooding compressor)	Wrong expansion valve superheating setting.	Adjust superheat setting.
	Expansion valve stuck open.	Repair/ replace expansion valve
	Refrigerant overcharge	Remove/ purge the excess refrigerant charge.
	Liquid line solenoid valve stuck open or held open manually.	Repair/ replace valve or restore to automatic operation.
14. a. Liquid line sweating or frosted.	Clogged filter drier	Replace drier elements/cores.
	Liquid line shut off valve partially closed.	Open valve fully.
b. Liquid line solenoid valve hisses when closed. Also, temperature change in refrigerant line through valve.	Leaking liquid line solenoid valve	Repair/ replace valve.
15. Condenser fan motor does not run.	Faulty wiring or loose connections.	Repair wiring or connections.
	Bad fan motor bearings.	Replace bearings or motor.
	Burntout fan motor.	Replace fan motor.
16. a. No LED/ LCD display on controllor or erratic display behaviour.	Problem with serial cable integrity, connections or controller malfunction.	Refer section on "Microprocessor controller" in this manual and take suitable corrective action.
b. Controller does not respond to keypad.	Jumper and/or dip switch wrong configuration	Check jumper and/or dip switch (refer to respective wiring diagram).
c. Auxilary board not responding to commands d. Analog outputs or digital outputs not responding. Possible controller message: ALARM COMPRESSOR N.X SERIAL COMMUNICATION.		

SYMPTOMS	POSSIBLE CAUSE	CORRECTIVE ACTION
e. Incorrect measurement/ reading of system parameters. Possible controller message: ALARM MASTER X. TR. OUT OF RANGE OR ALARM COMPRESSOR N.# X TR. OUT OF RANGE.	Problem with location, calibration and wiring of sensors/ transducers or controller malfunction.	Refer sections on "Microprocessor Controller" and "Calibration charts" and take suitable corrective action.
f. Unit provided with remote monitoring feature but serial communication with remote monitoring control not functioning properly. Possible controller message: ALARM MASTER SIM NOT READY OR ALARM MASTER GSM LOW SIGNAL	Problem with connections, gateway, modem etc.	Refer microprocessor cotroller section in this manual for detailed information on remote monitoring systems and take corrective action.
17. Chiller noisy	Improper unit mounting.	Check chiller mounting and vibration isolators. Take suitable corrective action.
	Loose parts or mountings inside the chiller.	Find and tighten.
	Refrigerant tubing rattle.	Check and correct tube supports.
	Condenser fan motor bearings worn.	Replace bearings or motor.
18. High chiller operating costs.	Insufficient compression - defective compressor.	Check compressor for internal damage, repair/ replace compressor.
	Shortage of refrigerant	Repair leak and recharge.
	High discharge pressures	Refer section 8 in this guide and take corrective action.
	Reduced cooler performance (cooler tubes fouled retarding heat transfer).	Check cooler efficiency & clean water side of cooler.
	Dirty condenser coil.	Clean coil.
	Water piping not insulated properly.	Insulate piping properly.

RECOMMENDED SPARE PARTS

ITEM	ONE YEAR SUPPLY		TWO YEAR SUPPLY	
	I UNIT	10 UNITS	I UNIT	10 UNITS
	EACH	EACH	EACH	EACH
Compressor	1	1	1	1
Evaporator			-	-
Condenser fan motor with fan	1	1	1	2
Controls				
Microprocessor main board	1	1	1	1
Microprocessor user interface board	1	1	1	1
Electronic expansion valve board	1	1	1	1
Electrical				
Compressor contactor	1	1	1	2
Compressor OLR	-	1	-	1
Compressor circuit breaker	-	1	-	1
Fan motor contactor	1	2	1	2
Fan motor circuit breaker	1	1	1	2
Transformer	1	1	1	1
Refrigerant circuits				
Electronic expansion valve.	-	1	-	1
Thermal expansion valve	-	1	-	1
Solenoid valve	1	1	1	1
Filter core	2	4	4	8
Sight glass	-	1	-	1
Others				
Flow switch	-	1	-	1
Oil pressurestat	1	1	1	2
Pressure transducer	1	1	1	1
PTC temperature sensor	1	1	1	1
High pressurestat	1	1	1	2
Low pressurestat	1	1	1	2
Sensors	-	1	-	1
Timer	1	1	1	2
Crankcase heater	1	1	1	1

Note : 1) When ordering spare parts, please specify the complete model number on the unit nameplate.

2) If quantity is written, it means, in each model, we must have that much quantity.

3) If percentage is written, number of components per unit multiplied by number of units and then percentage.

PART LIST (Refer also to common parts list)

MODEL NUMBER ASQ	045B	050B	055B	060B	070B	080B
COMPRESSOR CONTACTOR	80009868 (2)	80009868 (2)	80009751 (2)	80009751 (2)	80009754 (2)	80009868 (4)
COMPRESSOR OVERLOAD RELAY	80009894 (2)	80009894 (2)	80009722 (2)	80009722 (2)	80009722 (2)	80009894 (4)
FAN MOTOR CIRCUIT BREAKER	80060685 (2)	80060685 (2)	80060685 (2)	80060685 (2)	80060685 (2)	80060685 (3)
FAN MOTOR CONTACTOR	80009851 (4)	80009851 (4)	80009851 (4)	80009851 (4)	80009851 (4)	80009851 (6)
CONDENSER FAN MOTOR with FAN & GRILL	80055506 (4)	80055506 (4)	80055506 (4)	80055506 (4)	80023700 (4)	80023700 (6)
	80022432 (4)	80022432 (4)	80022432 (4)	80022432 (4)		
	80062538 (4)	80062538 (4)	80062538 (4)	80062538 (4)		
MICROPROCESSOR USER INTERFACE BOARD	80064650	80064650	80064650	80064650	80064650	80064650
MICROPROCESSOR MAIN BOARD	80064645	80064645	80064645	80064645	80064645	80064645
ELECTRONIC EXPANSION VALVE	80018155	80018155	80018155	80018155	80018164	80018155 (2)
ELECTRONIC EXPANSION VALVE BOARD	80064666	80064666	80064666	80064666	80064666	80064666
SIGHT GLASS	80020100	80020100	80020100	80020100	80020100	80020100 (2)
REPLACEABLE CORE FILTER DRIER	80053117	80053117	80053117	80053113	80053113	80053117 (2)
PUMP DOWN SOLENOID VALVE	80070665	80070665	80070665	80070665	80070665	80070665 (2)
ECONOMIZER THERMAL EXPANSION VALVE	NA	80018177	NA	NA	NA	NA
ECONOMIZER LINE SIGHT GLASS	NA	80020001	NA	NA	NA	NA
ECONOMIZER LINE SOLENOID VALVE	NA	80070521	NA	NA	NA	NA
LIQUID INJECTION LINE SOLENOID VALVE	80070652	80070652	80070652	80070652	80070652	80070652 (2)
PTC TEMPERATURE SENSOR	80064655 (4)	80064655 (4)	80064655 (4)	80064655 (4)	80064655 (4)	80064655 (6)
MAIN BOARD TRANSFORMER (24V)	80001200	80001200	80001200	80001200	80001200	80001200
OPTIONAL ITEMS						
HOT GAS BYPASS VALVE	80053341	80053341	80053341	80053341	80053341	80053341
WATER FLOW SWTICH	80055741	80055741	80055741	80055741	80055741	80055741
COMPRESSOR CIRCUIT BREAKER	80008732 (2)	80008732 (2)	80008733 (2)	80008733 (2)	80008734 (2)	80008732 (4)
MAIN NON-FUSED DISCONNECT SWITCH	80060963	80060963	80060963	80060964	80060964	80060965
SPRING ISOLATORS	80004709 (4)	80004709 (4)	80004710 (4)	80004710 (4)	80004710 (4)	80004710 (6)

MODEL NUMBER ASQ	090B	100B	115B	130B	140B	150B
COMPRESSOR CONTACTOR	80009868 (4)	80009751 (4)	80009751 (4)	80009754 (4)	80009754 (4)	80009754 (4)
COMPRESSOR OVERLOAD RELAY	80009894 (4)	80009722 (4)	80009722 (4)	80009722 (4)	80009722 (4)	80009722 (4)
FAN MOTOR CIRCUIT BREAKER	80060685 (3)	80060685 (3)	80060685 (4)	80060685 (4)	80060685 (5)	80060685 (5)
FAN MOTOR CONTACTOR	80009851 (6)	80009851 (6)	80009851 (8)	80009851 (8)	80009851 (10)	80009851 (10)
CONDENSER FAN MOTOR with FAN & GRILL	80023700 (6)	80023700 (6)	80023700 (8)	80023700 (8)	80023700 (10)	80023700 (10)
MICROPROCESSOR USER INTERFACE BOARD	80064650	80064650	80064650	80064650	80064650	80064650
MICROPROCESSOR MAIN BOARD	80064645	80064645	80064645	80064645	80064645	80064645
ELECTRONIC EXPANSION VALVE	80018155 (2)	80018155 (2)	80018155 (2)	80018164 (2)	80018164 (2)	80018164 (2)
ELECTRONIC EXPANSION VALVE BOARD	80064666	80064666	80064666	80064666	80064666	80064666
SIGHT GLASS	80020100 (2)	80020100 (2)	80020100 (2)	80020100 (2)	80020100 (2)	80020100 (2)
REPLACEABLE CORE FILTER DRIER	80053117 (2)	80053117 (2)	80053113 (2)	80053113 (2)	80053113 (2)	80053113 (2)
PUMP DOWN SOLENOID VALVE	80070665 (2)	80070665 (2)	80070665 (2)	80070665 (2)	80070665 (2)	80070665 (2)
ECONOMIZER THERMAL EXPANSION VALVE	80018177 (2)	NA	NA	NA	NA	80018177 (2)
ECONOMIZER LINE SIGHT GLASS	80020001 (2)	NA	NA	NA	NA	80020001 (2)
ECONOMIZER SOLENOID VALVE	80070521 (2)	NA	NA	NA	NA	80070521 (2)
LIQUID INJECTION LINE SOLENOID VALVE	80070652 (2)	80070652 (2)	80070652 (2)	80070652 (2)	80070652 (2)	80070652 (2)
PTC TEMPERATURE SENSOR	80064655 (6)	80064655 (6)	80064655 (6)	80064655 (6)	80064655 (6)	80064655 (6)
MAIN BOARD TRANSFORMER (24V)	80001200	80001200	80001200	80001200	80001200	80001200
OPTIONAL ITEMS						
HOT GAS BYPASS VALVE	80053341	80053341	80053341	80053341	80053341	80053341
WATER FLOW SWTICH	80055741	80055741	80055741	80055741	80055741	80055741
COMPRESSOR CIRCUIT BREAKER	80008732 (4)	80008733 (4)	80008733 (4)	80008734 (4)	80008734 (4)	80008734 (4)
MAIN NON-FUSED DISCONNECT SWITCH	80060965	80060965	80060966	80060967	80060967	80060967
SPRING ISOLATORS	80004710 (6)	80004711 (6)	80004711 (6)	80004712 (6)	80004711 (8)	80004711 (8)

PART LIST (Refer also to common parts list)

MODEL NUMBER ASQ	160B	170B	180B	190B	200B	220B
COMPRESSOR CONTACTOR	80009751 (6)	80009751 (4)	80009751 (4)	80009751 (6)	80009754 (6)	80009751 (4)
		80009751 (2)	80009751 (2)			80009751 (4)
COMPRESSOR OVERLOAD RELAY	80009722 (6)	80009722 (4)	80009722 (4)	80009722 (6)	80009722 (6)	80009722 (4)
		80009722 (2)	80009722 (2)			80009722 (4)
FAN MOTOR CIRCUIT BREAKER	80060685 (6)	80060685 (6)	80060685 (6)	80060685 (6)	80060685 (6)	80060685 (8)
FAN MOTOR CONTACTOR	80009851 (12)	80009851 (12)	80009851 (12)	80009851 (12)	80009851 (12)	80009851 (16)
CONDENSER FAN MOTOR with FAN & GRILL	80023700 (12)	80023700 (12)	80023700 (12)	80023700 (12)	80023700 (12)	80023700 (16)
MICROPROCESSOR USER INTERFACE BOARD	80064650	80064650	80064650	80064650	80064650	80064650
MICROPROCESSOR MAIN BOARD	80064645 (2)	80064645 (2)	80064645 (2)	80064645 (2)	80064645 (2)	80064645 (2)
ELECTRONIC EXPANSION VALVE	80018155 (3)	80018155 (3)	80018155 (3)	80018155 (3)	80018164 (3)	80018155 (4)
ELECTRONIC EXPANSION VALVE BOARD	80064666 (2)	80064666 (2)	80064666 (2)	80064666 (2)	80064666 (2)	80064666 (2)
SIGHT GLASS	80020100 (3)	80020100 (3)	80020100 (3)	80020100 (3)	80020100 (3)	80020100 (4)
REPLACEABLE CORE FILTER DRIER	80053117 (3)	80053117 (3)	80053113 (3)	80053113 (3)	80053113 (3)	80053117 (2)
						80053113 (2)
PUMP DOWN SOLENOID VALVE	80070665 (3)	80070665 (3)	80070665 (3)	80070665 (3)	80070665 (3)	80070665 (4)
ECONOMIZER THERMAL EXPANSION VALVE	NA	80018177 (2)	80018177 (2)	80018177 (3)	NA	NA
ECONOMIZER LINE SIGHT GLASS	NA	80020001 (2)	80020001 (2)	80020001 (3)	NA	NA
ECONOMIZER SOLENOID VALVE	NA	80070521 (2)	80070521 (2)	80070521 (3)	NA	NA
LIQUID INJECTION LINE SOLENOID VALVE	80070652 (3)	80070652 (3)	80070652 (3)	80070652 (3)	80070652 (3)	80070652 (4)
PTC TEMPERATURE SENSOR	80064655 (8)	80064655 (8)	80064655 (8)	80064655 (8)	80064655 (8)	80064655 (12)
MAIN BOARD TRANSFORMER (24V)	80001200	80001200	80001200	80001200	80001200	80001200
OPTIONAL ITEMS						
HOT GAS BYPASS VALVE	80053341	80053341	80053341	80053341	80053341	80053341
WATER FLOW SWTICH	80055741	80055741	80055741	80055741	80055741	80055741
COMPRESSOR CIRCUIT BREAKER	80008733 (6)	80008733 (4)	80008734 (4)	80008734 (6)	80008734 (6)	80008733 (4)
		80008733 (2)	80008733 (2)			80008733 (4)
MAIN NON-FUSED DISCONNECT SWITCH	80060967	80060967	80060968	80060968	80060968	80060968
SPRING ISOLATORS	80004712 (8)	80004712 (8)	80004712 (8)	80004712 (8)	80004712 (8)	80004712 (10)

MODEL NUMBER ASQ	230B	240B	250B	260B	270B	280B
COMPRESSOR CONTACTOR	80009751 (8)	80009754 (2)	80009754 (4)	80009754 (4)	80009754 (8)	80009754 (4)
		80009751 (6)	80009751 (4)	80009751 (4)		80009754 (4)
COMPRESSOR OVERLOAD RELAY	80009722 (8)	80009722 (2)	80009722 (4)	80009722 (4)	80009722 (8)	80009722 (4)
		80009722 (6)	80009722 (4)	80009722 (4)		80009722 (4)
FAN MOTOR CIRCUIT BREAKER	80060685 (8)	80060685 (8)	80060685 (8)	80060685 (8)	80060685 (8)	80060685 (8)
FAN MOTOR CONTACTOR	80009851 (16)	80009851 (16)	80009851 (16)	80009851 (16)	80009851 (16)	80009851 (16)
CONDENSER FAN MOTOR with FAN & GRILL	80023700 (16)	80023700 (16)	80023700 (16)	80023700 (16)	80023700 (16)	80023700 (16)
MICROPROCESSOR USER INTERFACE BOARD	80064650	80064650	80064650	80064650	80064650	80064650
MICROPROCESSOR MAIN BOARD	80064645 (2)	80064645 (2)	80064645 (2)	80064645 (2)	80064645 (2)	80064645 (2)
ELECTRONIC EXPANSION VALVE	80018155 (4)	80018155 (3)	80018155 (2)	80018155 (2)	80018164 (4)	80018164 (4)
		80018164 (1)	80018164 (2)	80018164 (2)		
ELECTRONIC EXPANSION VALVE BOARD	80064666 (2)	80064666 (2)	80064666 (2)	80064666 (2)	80064666 (2)	80064666 (2)
SIGHT GLASS	80020100 (4)	80020100 (4)	80020100 (4)	80020100 (4)	80020100 (4)	80020100 (4)
REPLACEABLE CORE FILTER DRIER	80053113 (4)	80053113 (4)	80053113 (4)	80053113 (4)	80053113 (4)	80053113 (4)
PUMP DOWN SOLENOID VALVE	80070665 (4)	80070665 (4)	80070665 (4)	80070665 (4)	80070665 (4)	80070665 (4)
ECONOMIZER THERMAL EXPANSION VALVE	NA	NA	NA	NA	NA	80018177 (2)
ECONOMIZER LINE SIGHT GLASS	NA	NA	NA	NA	NA	80020001 (2)
ECONOMIZER SOLENOID VALVE	NA	NA	NA	NA	NA	80070521 (2)
LIQUID INJECTION LINE SOLENOID VALVE	80070652 (4)	80070652 (4)	80070652 (4)	80070652 (4)	80070652 (4)	80070652 (4)
PTC TEMPERATURE SENSOR	80064655 (12)	80064655 (12)	80064655 (12)	80064655 (12)	80064655 (12)	80064655 (12)
MAIN BOARD TRANSFORMER (24V)	80001200	80001200	80001200	80001200	80001200	80001200
OPTIONAL ITEMS						
HOT GAS BYPASS VALVE	80053341	80053341	80053341	80053341	80053341	80053341
WATER FLOW SWTICH	80055741	80055741	80055741	80055741	80055741	80055741
COMPRESSOR CIRCUIT BREAKER	80008733 (8)	80008734 (2)	80008734 (4)	80008734 (4)	80008734 (8)	80008734 (4)
		80008733 (6)	80008733 (4)	80008733 (4)		80008733 (4)
MAIN NON-FUSED DISCONNECT SWITCH	80060968	80060968	80060968	80060968	80060968	80060968
SPRING ISOLATORS	80004712 (10)	80004712 (10)	80004712 (10)	80004712 (10)	80004712 (10)	80004712 (10)

PART LIST (Refer also to common parts list)

MODEL NUMBER ASQ	300B	320B	330B	340B	350B	360B
COMPRESSOR CONTACTOR	80009751 (8)	80009751 (4)	80009751 (6)	80009751 (12)	80009751 (12)	80009751 (6)
	80009868 (4)	80009751 (8)	80009751 (6)			80009751 (6)
COMPRESSOR OVERLOAD RELAY	80009722 (8)	80009722 (4)	80009722 (6)	80009722 (12)	80009722 (12)	80009722 (6)
	80009894 (4)	80009722 (8)	80009722 (8)			80009722 (6)
FAN MOTOR CIRCUIT BREAKER	80060685 (9)	80060685 (9)	80060685 (9)	80060685 (9)	80060685 (11)	80060685 (11)
FAN MOTOR CONTACTOR	80009851 (18)	80009851 (18)	80009851 (18)	80009851 (18)	80009851 (22)	80009851 (22)
CONDENSER FAN MOTOR with FAN & GRILL	80023700 (18)	80023700 (18)	80023700 (18)	80023700 (18)	80023700 (22)	80023700 (22)
MICROPROCESSOR USER INTERFACE BOARD	80064650	80064650	80064650	80064650	80064650	80064650
MICROPROCESSOR MAIN BOARD	80064645 (3)	80064645 (3)	80064645 (3)	80064645 (3)	80064645 (3)	80064645 (3)
ELECTRONIC EXPANSION VALVE	80018155 (4)	80018155 (4)	80018155 (3)	80018155 (6)	80018155 (6)	80018155 (3)
	80018155 (2)	80018155 (2)	80018155 (3)			80018155 (3)
ELECTRONIC EXPANSION VALVE BOARD	80064666 (3)	80064666 (3)	80064666 (3)	80064666 (3)	80064666 (3)	80064666 (3)
SIGHT GLASS	80020100 (6)	80020100 (6)	80020100 (6)	80020100 (6)	80020100 (6)	80020100 (6)
REPLACEABLE CORE FILTER DRIER	80053117 (6)	80053117 (6)	80053117 (6)	80053113 (6)	80053113 (6)	80053113 (6)
PUMP DOWN SOLENOID VALVE	80070665 (6)	80070665 (6)	80070665 (6)	80070665 (6)	80070665 (6)	80070665 (6)
ECONOMIZER THERMAL EXPANSION VALVE	80018177 (2)	80018177 (2)	80018177 (3)	NA	NA	80018177 (3)
ECONOMIZER LINE SIGHT GLASS	80020001 (2)	80020001 (2)	80020001 (3)	NA	NA	80020001 (3)
ECONOMIZER SOLENOID VALVE	80070521 (2)	80070521 (2)	80070521 (3)	NA	NA	80070521 (3)
LIQUID INJECTION LINE SOLENOID VALVE	80070652 (6)	80070652 (6)	80070652 (6)	80070652 (6)	80070652 (6)	80070652 (6)
PTC TEMPERATURE SENSOR	80064655 (16)	80064655 (16)	80064655 (16)	80064655 (16)	80064655 (16)	80064655 (16)
MAIN BOARD TRANSFORMER (24V)	80001215	80001215	80001215	80001215	80001215	80001215
OPTIONAL ITEMS						
HOT GAS BYPASS VALVE	80053341	80053341	80053341	80053341	80053341	80053341
WATER FLOW SWTICH	80055741	80055741	80055741	80055741	80055741	80055741
COMPRESSOR CIRCUIT BREAKER	80008733 (8)	80008733 (4)	80008733 (6)	80008733 (12)	80008733 (12)	80008734 (6)
	80008732 (4)	80008733 (8)	80008733 (6)			80008733 (6)
MAIN NON-FUSED DISCONNECT SWITCH	80060969	80060969	80060969	80060969	80060969	80060969
SPRING ISOLATORS	80004712 (14)	80004712 (14)	80004712 (14)	80004712 (14)	80004772 (14)	80004772 (14)

MODEL NUMBER ASQ	380B	400B	420B	440B		
COMPRESSOR CONTACTOR	80009754 (8)	80009754 (12)	80009754 (6)	80009754 (12)		
	80009751 (4)		80009754 (6)			
COMPRESSOR OVERLOAD RELAY	80009722 (8)	80009722 (12)	80009722 (6)	80009722 (12)		
	80009722 (4)		80009722 (6)			
FAN MOTOR CIRCUIT BREAKER	80060685 (11)	80060685 (11)	80060685 (11)	80060685 (11)		
FAN MOTOR CONTACTOR	80009851 (22)	80009851 (22)	80009851 (22)	80009851 (22)		
CONDENSER FAN MOTOR with FAN & GRILL	80023700 (22)	80023700 (22)	80023700 (22)	80023700 (22)		
MICROPROCESSOR USER INTERFACE BOARD	80064650	80064650	80064650	80064650		
MICROPROCESSOR MAIN BOARD	80064645 (3)	80064645 (3)	80064645 (3)	80064645 (3)		
ELECTRONIC EXPANSION VALVE	80018164 (4)	80018164 (6)	80018164 (3)	80018164 (6)		
	80018155 (2)		80018164 (3)			
ELECTRONIC EXPANSION VALVE BOARD	80064666 (3)	80064666 (3)	80064666 (3)	80064666 (3)		
SIGHT GLASS	80020100 (6)	80020100 (6)	80020100 (6)	80020100 (6)		
REPLACEABLE CORE FILTER DRIER	80053113 (6)	80053113 (6)	80053113 (6)	80053113 (6)		
PUMP DOWN SOLENOID VALVE	80070665 (6)	80070665 (6)	80070665 (6)	80070665 (6)		
ECONOMIZER THERMAL EXPANSION VALVE	NA	NA	80018177 (3)	80018177 (6)		
ECONOMIZER LINE SIGHT GLASS	NA	NA	80020001 (3)	80020001 (6)		
ECONOMIZER SOLENOID VALVE	NA	NA	80070521 (3)	80070521 (6)		
LIQUID INJECTION LINE SOLENOID VALVE	80070652 (6)	80070652 (6)	80070652 (6)	80070652 (6)		
PTC TEMPERATURE SENSOR	80064655 (16)	80064655 (16)	80064655 (16)	80064655 (16)		
MAIN BOARD TRANSFORMER (24V)	80001215	80001215	80001215	80001215		
OPTIONAL ITEMS						
HOT GAS BYPASS VALVE	80053341	80053341	80053341	80053341		
WATER FLOW SWTICH	80055741	80055741	80055741	80055741		
COMPRESSOR CIRCUIT BREAKER	80008734 (8)	80008734 (12)	80008734 (6)	80008734 (12)		
	80008733 (4)		80008734 (6)			
MAIN NON-FUSED DISCONNECT SWITCH	80060969	80060969	80060969	80060969		
SPRING ISOLATORS	80004772 (14)	80004772 (14)	80004772 (14)	80004772 (14)		

DISCHARGE PRESSURE TRANSDUCER :80064666
SUCTION PRESSURE TRANSDUCER :80064658
UNDER/OVER VOLTAGE MONITOR :80001345
FILTER DRIER CORE :80002765 (REFER FILTER DRIER SPECIFICATION FOR QTY.)

NOTE :

1-REFER TO PHYSICAL DATA FOR COMPRESSOR, COOLER AND ECONOMIZER PART NUMBERS.
2-DATA ENCLOSED BY PARENTHESIS MEANS QUANTITY.
3- FOR ASQ045B TO ASQ060B, THE FAN MOTOR, FAN AND GRILL HAVE SEPARATE PART NO.S UNLIKE ALL OTHER CHILLERS.
4- SPRING ISOLATOR SELECTION IS BASED ON ALUMINUM FIN CONDENSER COIL FOR CHILLERS, CONSULT FACTORY FOR SELECTION OF SPRING ISOLATORS FOR CHILLERS WITH COPPER FIN CONDENSER COILS.

MATERIAL SAFETY DATA SHEET

SAFETY DATA	REFRIGERANT R134a
Toxicity	NIL
In Contact With Skin	Liquid splashes or spray may cause freeze burns. Unlikely to be hazardous by skin absorption. Thaw affected areas with water. Remove contaminated clothing carefully - may adhere to skin in case of freeze burns. Wash affected areas with plenty of warm water. If symptoms occur (irritation or blistering), obtain medical attention.
In Contact With Eyes	Contact with liquid or cold vapor can cause freezing of tissue. Immediately flush with plenty of clean water for at least 15 minutes. Obtain immediate medical attention.
Inhalation	High concentration of HFC 134a vapor is harmful. It can act as an asphyxiant by limiting available oxygen. Human health effects of overexposure to HFC- 134a vapors by inhalation may include temporary nervous system depression with anaesthetic effects such as dizziness, headache, confusion, incoordination and loss of consciousness. At very high doses, cardiac sensitization to circulating epinephrine-like compounds can result in fatal cardiac arrhythmias. If large concentrations are inhaled, immediately remove to fresh air. Keep person calm. If not breathing, give artificial respiration, perferably mouth to mouth. If breathing is labored, give oxygen. In the event of cardiac arrest, apply external cardiac massage. Do not admininster adreneline or similar sympathominectic drugs as cardiac arrhythmias may result. Get immediate medical attention.
Stability	Stable under normal conditions.
Conditions to Avoid	Any source of ignition, such as lighted cigarettes, flames, hot spots, welding.
Materials to Avoid	Finely divided metals, magnesium and alloys conatining more than 2% magnesium. Can react violently if in contact with alkali earth metals such as sodium, potassium, calcium, barium, powdered aluminium, magnesium and Zinc.
Hazardous Decomposition Products	Halogens, halogen acids and possibly carbonyl halides such as phosgene. These are toxic and corrosive.
General Precautions	Avoid inhalation of high concentrations of vapors. Atmospheric concentrations should be minimized and kept as low as possible. The vapor is heavier than air and collects at low level and in confined areas. Ventilate by extraction at lowest levels.
Respiratory Protection	Where doubt exists on atmospheric concentration, suitable breathing apparatus should be worn. This should be self-contained or of the long breather type.
Storage	Store in a cool, well-ventilated area of low fire risk. Keep cylinders dry. Cylinders should be stored upright with valve protection cap in place and firmly secured to prevent falling or being knocked over. Protect cylinders from physical damage; do not drag, roll, slide or drop. Do not allow storage area temperature to exceed 113ºF (45ºC). Keep away from direct sunlight, heat and sources of ignition. Full and empty cylinders should be segregated. Use a first-in, first-out inventory system to prevent full containers from being stored for long periods of time.
Protective Clothing	Wear overalls, impervious gloves and goggles/face protection.
Spill / leak Procedure	Ensure suitable personal protective clothing and respiratory protection is worn. Evacuate all personnel from the affected area. Shut off source of leak, if possible without risk. Ventilate spill area, especially low places where heavy vapors might collect. If possible dike and contain spillage. Prevent liquid from entering sewers, sumps or pit areas, since vapor can create suffocating atmosphere. Allow spilled liquid to evaporate.
Disposal	Best to recover and recycle. If this is not possible, destruction is to be in an approved facility which is equipped to absorb and neutralize acids and other toxic processing products.
Fire Extinguishing Data	Non-flammable.
Containers	Fire exposed containers should be kept cool with water sprays. Containers may burst if overheated.
Fire Fighting Protective Equip.	Self-contained breathing apparatus and protective clothing must be worn in fire conditions.

PRESSURE TEMPERATURE CHART- R134a

Temperature ºF	Pressure		Temperature ºC	Pressure	
	PSIA	PSIG		Kpa (Absolute)	Kpa (Gauge)
0	21.2	6.5	-17.78	146.2	44.9
2	22.2	7.5	-16.67	153.2	51.8
4	23.3	8.6	-15.56	160.4	59.1
6	24.3	9.6	-14.44	167.9	66.6
8	25.5	10.8	-13.33	175.7	74.3
10	26.6	11.9	-12.22	183.7	82.4
12	27.8	13.2	-11.11	192.0	90.7
14	29.1	14.4	-10.00	200.7	99.3
16	30.4	15.7	-8.89	209.6	108.3
18	31.7	17.0	-7.78	218.8	117.5
20	33.1	18.4	-6.67	228.4	127.0
22	34.5	19.8	-5.56	238.2	136.9
24	36.0	21.3	-4.44	248.4	147.1
26	37.5	22.9	-3.33	258.9	157.6
28	39.1	24.4	-2.22	269.8	168.5
30	40.7	26.1	-1.11	281.0	179.7
32	42.4	27.7	0.00	292.6	191.3
34	44.2	29.5	1.11	304.6	203.2
36	45.9	31.3	2.22	316.9	215.5
38	47.8	33.1	3.33	329.6	228.2
40	49.7	35.0	4.44	342.6	241.3
42	51.6	36.9	5.56	356.1	254.8
44	53.7	39.0	6.67	370.0	268.7
46	55.7	41.0	7.78	384.3	283.0
48	57.9	43.2	8.89	399.0	297.7
50	60.0	45.4	10.00	414.1	312.8
52	62.3	47.6	11.11	429.7	328.4
54	64.6	49.9	12.22	445.7	344.4
56	67.0	52.3	13.33	462.2	360.9
58	69.5	54.8	14.44	479.1	377.8
60	72.0	57.3	15.56	496.5	395.2
62	74.6	59.9	16.67	514.4	413.0
64	77.2	62.6	17.78	532.7	431.4
66	80.0	65.3	18.89	551.6	450.2
68	82.8	68.1	20.00	570.9	469.6
70	85.7	71.0	21.11	590.8	489.4
72	88.6	73.9	22.22	611.1	509.8
74	91.6	77.0	23.33	632.0	530.7
76	94.8	80.1	24.44	653.5	552.1
78	97.9	83.2	25.56	675.4	574.1
80	101.2	86.5	26.67	698.0	596.6
82	104.6	89.9	27.78	721.1	619.7
84	108.0	93.3	28.89	744.7	643.4
86	111.5	96.8	29.95	769.0	667.6

PRESSURE TEMPERATURE CHART- R134a

Temperature ºF	Pressure		Temperature ºC	Pressure	
	PSIA	PSIG		Kpa (Absolute)	Kpa (Gauge)
88	115.1	100.4	31.11	793.8	692.5
90	118.8	104.1	32.22	819.2	717.9
92	122.6	107.9	33.33	845.3	743.9
94	126.4	111.7	34.44	871.9	770.6
96	130.4	115.7	35.56	899.2	797.9
98	134.4	119.7	36.67	927.1	825.8
100	138.6	123.9	37.78	955.7	854.3
102	142.8	128.1	38.89	984.9	883.6
104	147.1	132.4	40.00	1014.8	913.4
106	151.6	136.9	41.11	1045.3	944.0
108	156.1	141.4	42.22	1076.6	975.2
110	160.7	146.0	43.33	1108.5	1007.2
112	165.5	150.8	44.44	1141.2	1039.8
114	170.3	155.6	45.56	1174.5	1073.2
116	175.2	160.6	46.67	1208.6	1107.3
118	180.3	165.6	47.78	1243.4	1142.1
120	185.5	170.8	48.89	1279.0	1177.7
122	190.7	176.0	50.00	1315.3	1214.0
124	196.1	181.4	51.11	1352.4	1251.1
126	201.6	186.9	52.22	1390.3	1288.9
128	207.2	192.5	53.33	1428.9	1327.6
130	212.9	198.2	54.44	1468.4	1367.1
132	218.8	204.1	55.56	1508.7	1407.4
134	224.7	210.0	56.67	1549.8	1448.5
136	230.8	216.1	57.78	1591.7	1490.4
138	237.0	222.3	58.89	1634.5	1533.2
140	243.3	228.6	60.00	1678.2	1576.8
142	249.8	235.1	61.11	1722.7	1621.4
144	256.4	241.7	62.22	1768.1	1666.8
146	263.1	248.4	63.33	1814.4	1713.1
148	269.9	255.2	64.44	1861.6	1760.3
150	276.9	262.2	65.56	1909.8	1808.5
152	284.0	269.3	66.67	1958.9	1857.6
154	291.3	276.6	67.78	2008.9	1907.6
156	298.7	284.0	68.89	2059.9	1958.6
158	306.2	291.5	70.00	2111.9	2010.6
160	313.9	299.2	71.11	2164.9	2063.6
162	321.7	307.1	72.22	2218.9	2117.6
164	329.7	315.0	73.33	2274.0	2172.7
166	337.9	323.2	74.44	2330.1	2228.7
168	346.1	331.5	75.56	2387.2	2285.9
170	354.6	339.9	76.67	2445.4	2344.1

USEFUL EQUATION AND DATA

WATER SYSTEM EQUATION:

H = 500 x GPM x Δ T

H = Total heat (Btu/ Hr.)
GPM = Water flow rate (Gallons per minute)
Δ T = Temperature difference (°F)
500 = Equation factor

For systems with glycol solution, this equation can be used with a modified equation factor (depending on the glycol concentration as tabulated below:

Ethylene Glycol

% GLYCOL SOLUTION	TEMPERATURE °F.		SPECIFIC HEAT	SPECIFIC GRAVITY (1)	EQUATION FACTOR
	FREEZE POINT	BOILING POINT			
0	+32	212	1.00	1.000	500
10	+26	214	0.97	1.012	491
20	+16	216	0.94	1.027	483
30	+4	220	0.89	1.04	463
40	-12	222	0.83	1.055	438
50	34	225	0.78	1.067	416
60	-60	232	0.73	1.079	394
70	<-60	244	0.69	1.091	376
80	-49	258	0.64	1.101	352
90	20	287	0.60	1.109	333
100	+10	287+	0.55	1.116	307

Notes:
1. Specific gravity with respect to water at 60°F.

SYMBOLS COMMONLY USED IN CHILLED WATER PLANT DRAWINGS:

Piping:

Chilled water supply	——CWS——
Chilled water return	——CWR——
Brine supply	——B——
Brine return	——BR——
Drain	——D——
Condensate drain above floor or grade	——CD——
Condensate drain below floor or grade	- - - -CD- - - -

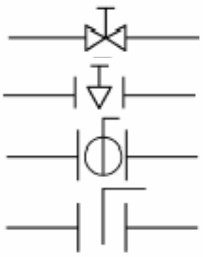
Valves:

Gate

Plug valve

Ball

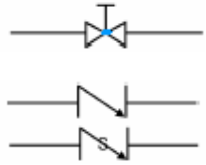
Butterfly



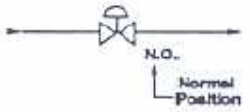
Globe

Check, swing gate

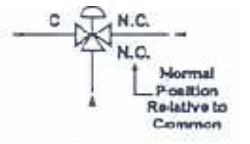
Check, spring



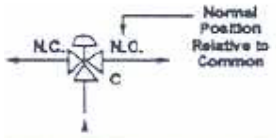
2-Way
Control Valve



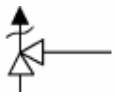
3-Way
Mixing Valve



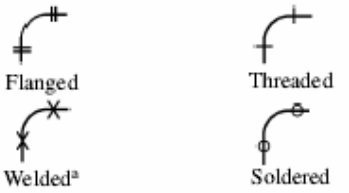
3-Way
Diverting Valve



Relief (R) or safety (S)



Fittings:



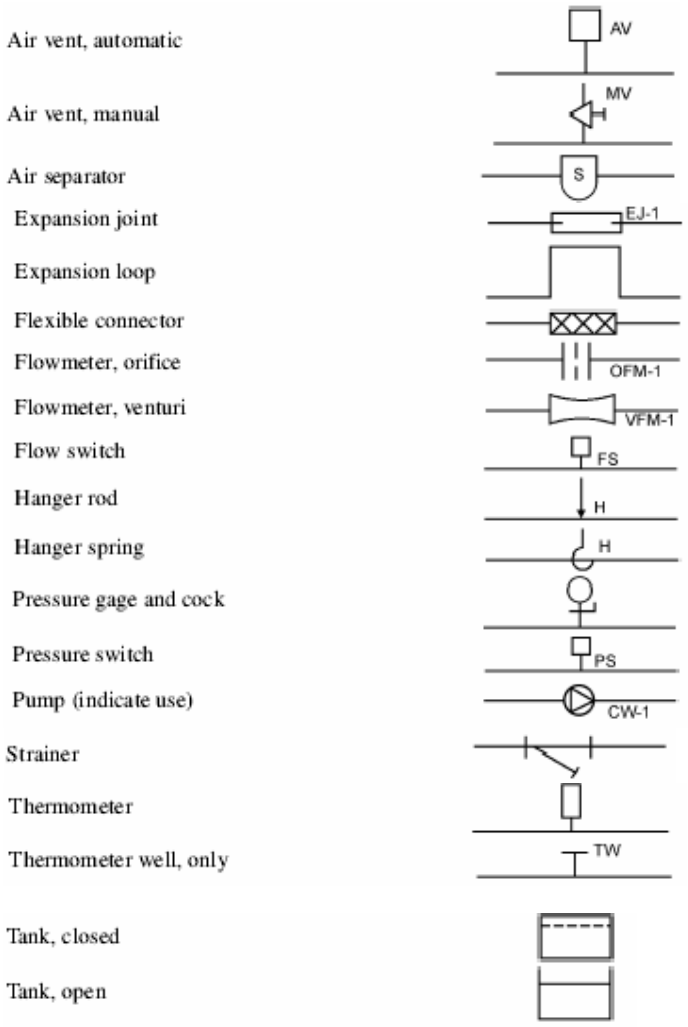
Cap

Reducer, concentric

Union, screwed

Union, flanged

Piping Specialities:



Electrical:

In order to ensure trouble-free operation and to avoid damage to this equipment, periodic maintenance is necessary. Careful maintenance attention can pay big dividends in efficient operation, lower operating cost, reduced down time and long satisfactory service life which can be ensured by drawing up a MAINTENANCE CONTRACT with a professional service company like Zamil CoolCare. For more information please contact them at their following addresses.

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